BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 11-231

1 JULY 1998

Flying Operations

COMPUTED AIR RELEASE POINT PROCEDURES

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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Certified by: HQ USAF/XOO (Maj Gen Charles R. Henderson)

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This instruction implements AFPD 11-2, *Flight Rules and Procedures*, by prescribing standard methods and terminology for employment of the Computed Air Release Point (CARP) system. This system governs aircrew involved computing air release point data during employment phases of aerial delivery operations.

Chapter 1

INTRODUCTION

1.1. General . This instruction provides information for computed air release systems for airdrop of equipment and personnel.

1.2. Applicability. This instruction applies to all US Air Force aircrew members directly involved in computing air release points for airdrop operations of parachutists, equipment, supply bundles, and training bundles. HQ AMC is the lead command for this instruction. Individual major commands (MAJCOM) may supplement and waive elements of this instruction for operational necessity. Send information pertaining to any supplement or waiver to this instruction to the lead command as soon as practical. Individual MAJCOMs will be responsible for providing HQ AMC ballistic data specific to their command or mission. Additionally, all lead MAJCOMs must identify which items in this AFI apply to their aircrews for use in their specific mission. Note: Some aircraft are capable of computing wind adjusted release points solutions through onboard mission computers without the use of procedures contained in the instruction.

1.3. Administration. Organization commanders will ensure distribution of one copy per aircrew member who is directly involved in calculating air release points and one copy per operations section of airdrop tasked units. Holders are responsible for posting revisions and changes.

1.4. Recommended Changes. Use AF Form 847, **Recommendation for Change of Publication**, according to AFI 11-215, **Flight Manuals Program (FMP),** to recommend a change to this instruction. All AF Forms 847 must be approved by HQ AMC/DOV, through respective MAJCOM channels.

1.5. Deviations. Deviations to this instruction are authorized for safety or protection of aircrew or aircraft. As soon as possible, inform respective MAJCOM of reason for deviation and course of action taken. For other types of deviation, submit waiver requests through normal channels to respective MAJCOM. File approved waivers in the back of this instruction until expired or rescinded.

1.6. Individual Circular Error Record (does not apply to AFSOC or C-17 units). Each unit will maintain Circular Error (CE) records for aircrew members (primarily navigators) who are responsible for CARP computations and who initiate the airdrop sequence. Use AF Form 4012, **Individual Air Drop Circular Error Record**. Compute a separate CEA for each category listed below. Use the last ten (10) airdrops for each category or those recorded within the last six months (whichever is less). Record a drop score over 600 yards as a 600 yards Circular Error Average (CEA). Aircrew members, defined in this paragraph, must receive supervised training if their CEA exceeds 225 yards. Confirmed equipment malfunctions, troop exit delays, releases not controlled by the aircrew (such as jumpmaster directed airdrops), and racetracks will not be included in the computations. Use the following categories:

1.6.1. Actual personnel - visual day and night separately.

1.6.2. Actual heavy equipment - visual day and night separately.

1.6.3. Actual Container Delivery System (CDS) - visual day and night separately.

1.6.4. Standard Airdrop Training Bundle (SATB) - visual day and night reported together.

1.6.5. Zone Marker or SKE timing - all.

1.6.6. AWADS or AUTOCARP - all.

NOTES:

Included SATBs released on actual CARPs for sight angle training in the appropriate actual load computations.

Units may track CEAs for pilots flying the aircraft as well as by tail numbers (to determine or verify trends in alignment or equipment performance).

1.7. Successful Airdrop Criteria:

1.7.1. Unilateral training. Successful criteria is governed by applicable MAJCOM instructions or supplements.

1.7.2. Other than unilateral training. Score airdrop events as successful if 90 percent of the loads land within the boundaries of the surveyed DZ and are recovered in usable condition by friendly forces.

Chapter 2

COMPUTED AIR RELEASE POINT (CARP) SYSTEM

2.1. General . The CARP solution is based on average parachute ballistics and fundamental dead reckoning principles. These principles, laid out in this instruction, minimize errors while providing ease of preflight and inflight mission planning.

2.2. Responsibility. The aircrew member who initiates the airdrop sequence computes the release point solution for all airdrops. The actual computation of the computed release point may be accomplished for a formation by a designated qualified aircrew member. However, each individual aircrew is responsible for its accuracy. The pilot flying the aircraft assumes responsibility for maintaining drift offset and required track during run-in. The navigator (or pilot not flying the aircraft when a navigator is not part of the crew) controls the time to airdrop sequence initiation, "Green Light." This crewmember also controls the end of usable drop zone time "Red Light" and updates the required drift offset for the pilot to fly. Aircrew members must have a thorough understanding of this system. Complete cooperation and teamwork between these crew positions is essential for best results. Exception: HC-130 unique airdrops maybe initiated IAW mission specific procedures.

Exception: C-17 Procedures. The C-17 utilizes an onboard mission computer (MC) system to compute a CARP solution. Both pilots are responsible for ensuring all computer entries are correct. The MC controls the time to airdrop sequence initiation, "Green Light." It also controls the end of usable drop zone time, "Red Light," and updates the required drift offset for the pilot to fly.

2.3. Methods of Airdrop.

2.3.1. Personnel and Door Bundle. This type of airdrop load either exits, is pushed, or is skidded from the paratroop door or aircraft ramp and door.

2.3.2. Gravity. The aircraft maintains a "nose-high" attitude (if required) and inflight release of load restraint allows the load to roll out of the aircraft. A rigging system may be used to initiate and accelerate load movement.

2.3.3. Extraction. An extraction parachute pulls the load from the cargo compartment.

2.4. Types of Airdrop.

2.4.1. Free-Fall. Delivery of non-fragile items without the use of parachutes. Loads require special preparation to prevent damage from impact.

2.4.2. High Velocity (Hi-V). Delivery of certain supply items rigged in containers with an energy dissipater attached to the underside and supported by a ring-slot parachute. The ring-slot parachute stabilizes the load and retards the rate of fall to the point of acceptable landing shock. This system may include equipment loads dropped using reefed parachutes.

2.4.3. Low Velocity. Delivery of personnel and various items of supply and equipment by use of cargo parachutes. Loads are prepared for airdrop by packing items in airdrop containers or by rigging them on platforms.

2.5. Governing Factors:

2.5.1. The CARP is based on the first load to exit the aircraft (Exception: When door bundles precede personnel, compute separate CARPs for the personnel and for the bundle. Release the bundle on the personnel CARP after ensuring that the bundle will impact on the surveyed DZ).

2.5.2. The actual ground pattern of sequentially airdropped loads depends on the following:

2.5.2.1. Time lapse between “Green Light” and time of exit of last item.

2.5.2.2. Aircraft stability from release to “Red Light.”

2.5.2.3. Uniformity of loads and/or parachutes within an element.

2.5.2.4. Glide angle of individual parachutes.

2.5.2.5. Ability of jumper to see desired landing point and steer to it.

2.5.2.6. Aircraft track from “Green Light” to “Red Light”

2.5.2.7. Aircraft altitude and speed.

2.5.2.8. Weather (primarily winds).

2.5.3. Accurate airdrop requires timely drop zone or drop zone target acquisition to assure proper alignment. The alignment or cross track drift offset, based on the most current winds, must be maintained during the final approach to the release point and throughout the drop period.

2.6. Parachute Characteristics:

2.6.1. Parachute Ballistics. Each parachute has its own peculiarities. The ballistics given in this instruction are acceptable averages. This testing is conducted by the US Army Airborne Board, US Army Quartermaster Corps, and US Army Natick Laboratories. USAF Aeronautical Systems Center at Wright-Patterson Air Force Base validates the tested ballistics for aircrew use.

2.6.2. Gliding Angle. Some parachutes (e.g., T-10) glide randomly in direction. Others (e.g., MT-1) are designed to glide in one direction. Unless the direction and speed of the glide are known, this factor cannot be accounted for in the CARP.

2.7. Drop Winds. Use a composite of altitude and surface winds (if known) to determine drift effect. The most accurate drop wind is one obtained at drop altitude and airspeed shortly before the drop. When interpolating a mean effective wind (vectorial average from all sources), take care to consider direction as well as velocity, and consider weather or other phenomena that may cause wind shear between drop altitude and the surface. Remember, the higher the drop altitude, the greater the drift effect per knot of wind. Note: When averaging winds to arrive at a ballistic wind, use a vectorial wind average. Using a mathematical average will introduce errors into the CARP solution. Wind sources include, but are not limited to the following:

2.7.1. Forecast winds.

NOTE:

Weather facilities report winds in true bearing.

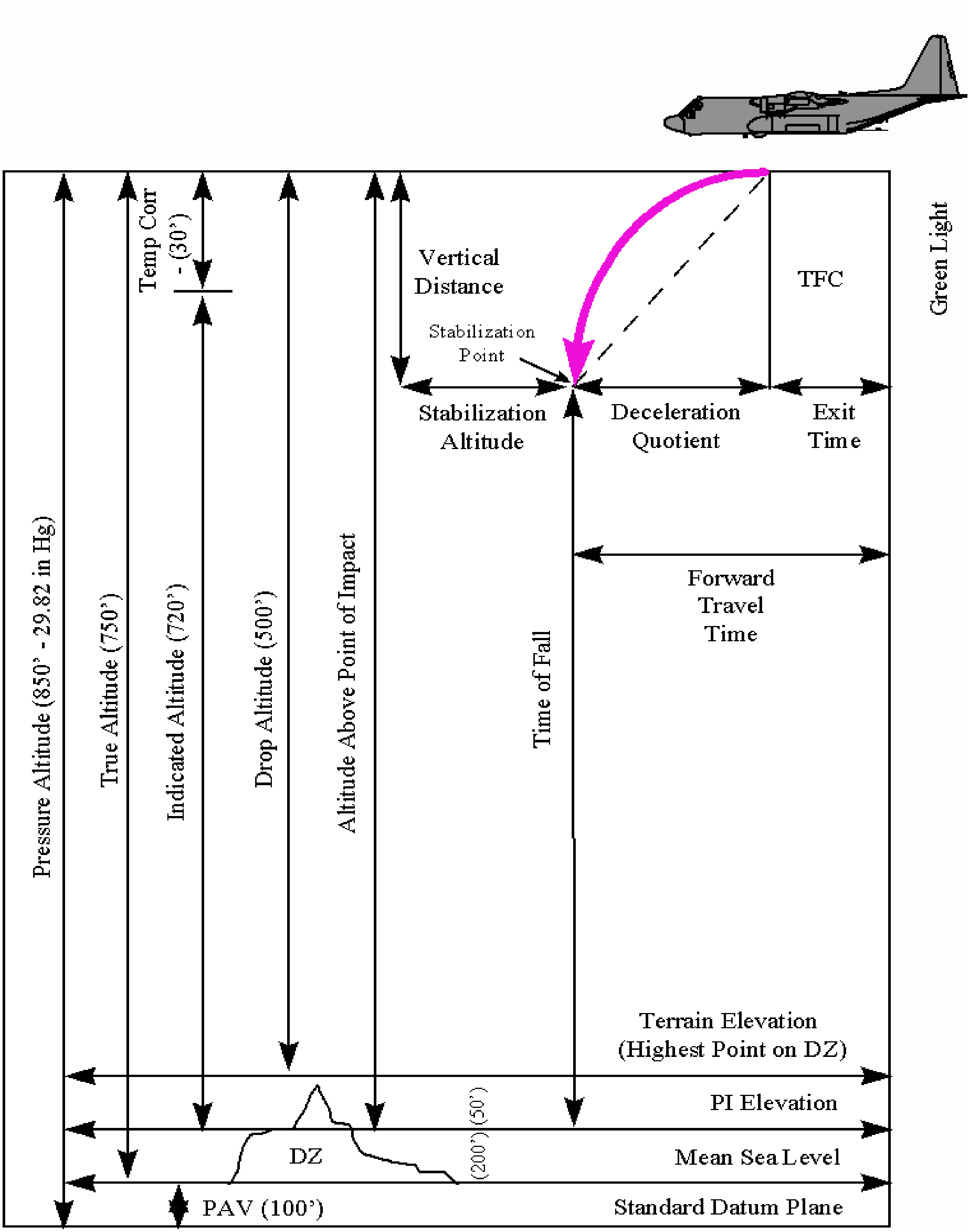
2.7.2. Inflight visual indications of wind (smoke, dust, etc.).

2.7.3. Electronic and navigation systems (Doppler, SCNS, INS, GPS, LIDAR, etc.).

2.7.4. Ground party (CCT, STT, and DZC) furnished magnetic winds. Normally, the ground party reports winds as a Mean Effective Wind (MEW). The MEW is a theoretical wind, referenced in constant speed and direction, extending from the DZ surface to drop altitude. When verified with inflight data, aircrews should consider the MEW a very desirable source.

2.8. Drop Zones. AFI 13-217, **Assault Zone Procedures, Chapter 2** contains DZ information.

Figure 2.1. CARP Diagram.



Chapter 3

COMPUTED AIR RELEASE POINT SOLUTIONS

3.1. General . The primary solution for computing the air release point is the basic computer solution where all requirements are solved using the MB-4 or MAJCOM approved computer software. Note: For C-17 operations, all computations are stored in the computer and no paper documentation is required. Chute ballistic data is contained in a database within the MC.

3.2. Basic Computed Air Release Point (CARP) Solutions (Does not apply to C-17). The AF Form 4018, **Computed Air Release Point Computation**, or MAJCOM approved software generate products, will be used to solve and record data. **Figure 3.1.** provides sample CARP solutions for CDS, Heavy Equipment and Personnel. The basic steps for the AF Form 4018 are as follows:

3.2.1. Item 1. Drop altitude: Selected AGL drop altitude (absolute altitude) in feet.

3.2.2. Item 2. Terrain Elevation: Elevation, in feet, of the highest point on the surveyed DZ.

3.2.3. Item 3. True Altitude: Computed mean sea level (MSL) drop altitude, in feet (item 1 plus item 2). True altitude is the altitude to be flown when the altimeter setting is derived by in-flight altimeter calibration.

3.2.4. Item 4. Pressure Altitude Variation (PAV): The pressure difference, in feet, between mean sea level and the standard datum plane. PAV is computed by taking the difference between the forecast DZ altimeter setting and the standard day pressure (29.92 in Hg) and multiplying by 10. PAV is positive if the forecast altimeter setting is less than 29.92 and negative if the forecast altimeter setting is greater than 29.92 (formula A).

3.2.5. Item 5. Pressure Altitude: Drop altitude, in feet above the standard datum plane (item 3 plus item 4). Used to compute true airspeed and corrected drop altitude.

3.2.6. Item 6. Corrected Drop Altitude: Drop altitude corrected for air density by using formula B and the ALTITUDE CALCULATIONS window on the MB-4 computer.

$$\frac{\text{True Alt Temp}}{\text{Pressure Altitude}} = \frac{\text{Drop Altitude}}{\text{(Corrected Drop Altitude)}}$$

3.2.7. Item 7. Terrain Elevation: Same as item 2.

3.2.8. Item 8. Indicated Altitude: The altitude to be flown with the DZ altimeter setting set in the barometric scale of the aircraft altimeter.

3.2.9. Item 9. True Altitude Temperature: Temperature in degrees Celsius. Used to compute item 6 and item 11.

3.2.10. Item 10. IAS/CAS/EAS: Indicated airspeed (IAS) for the drop as specified by the appropriate directives. Calibrated airspeed (CAS) equals IAS corrected for pitot static error, aircraft attitude, and instrument error. Equivalent airspeed (EAS) equals CAS corrected for compressibility. Log CAS/EAS only when different from IAS.

3.2.11. Item 11. True Airspeed: True airspeed (TAS) is computed on the MB-4 using the DENSITY ALTITUDE COMPUTATIONS window and the formula:

$$\frac{\text{Temperature}}{\text{Pressure Altitude}} = \frac{\text{(TAS)}}{\text{EAS}}$$

3.2.12. Item 12. Rate of Fall (RF): Extracted from the parachute ballistic data. This velocity is expressed in feet per second.

3.2.13. Item 13. Adjusted Rate of Fall: RF corrected for air density. Compute on the MB-4 computer using the DENSITY ALTITUDE COMPUTATIONS window and formula C.

$$\frac{\text{Average Temperature}}{\text{Average Pressure Alt.}} = \frac{\text{(Adjusted Rate of Fall)}}{\text{Rate of Fall}}$$

NOTE:

Average Pressure Altitude is calculated by taking item 5 minus one-half of item 1.

3.2.14. Item 14. Altitude Above Point of Impact: The difference in feet between the PI and the highest point on the DZ (terrain elevation) measured in feet AGL (formula D).

3.2.15. Item 15. Vertical Distance: Extracted from the parachute ballistic data.

3.2.16. Item 16. Stabilization Altitude: Item 14 minus item 15.

3.2.17. Item 17. Time of Fall: The elapsed time, in seconds, it takes for the load to fall from stabilization altitude to the PI. Compute using formula E.

$$\frac{\text{Adjusted Rate of Fall}}{\text{Stabilization Altitude}} = \frac{1.0}{\text{(Time of Fall)}}$$

3.2.18. Item 18. Time of Fall Constant: Extracted from the parachute ballistic data.

3.2.19. Item 19. Total time of Fall: Item 17 plus item 18.

3.2.20. Item 20. Ballistic Wind: The expected wind, interpolated from all available sources, which will affect the load on its way the ground.

NOTE:

CCT/STT furnished surface and mean effective winds are reported as magnetic, while onboard computers may provide winds in magnetic, true or grid reference.

3.2.21. Item 21. Drift Effect: Distance in yards computed using formula F.

$$\frac{\text{Total Time of Fall}}{1.78} = \frac{\text{(Drift Effect)}}{\text{Wind Speed}}$$

NOTE:

The 1.78 constant is used to convert knots to yards per second. 1.94 constant is used to convert knots to meters per second. Item 21 may be divided to include space for drift effect based the increment used in constructing the wind circle (see paragraph **4.5.**).

3.2.22. Item 22. Drop Altitude Wind: Expected wind at drop altitude. Used to compute drift and groundspeed.

3.2.23. Item 23. DZ Course: DZ centerline course referenced in magnetic, true, or grid obtained from the DZ survey or Assault Zone Availability Report (AZAR).

3.2.24. Item 24. Drift Correction: Expected run-in heading correction necessary to parallel DZ course.

3.2.25. Item 25. DZ Heading: Item 23 corrected by item 24.

3.2.26. Item 26. Groundspeed: Expected aircraft speed relative to the ground. Aircraft TAS corrected for forecast wind.

3.2.27. Item 27. Exit Time: Extracted from the parachute ballistic data.

3.2.28. Item 28. Deceleration Quotient: Extracted from the parachute ballistic data.

3.2.29. Item 29. Forward Travel Time: Item 27 plus item 28 or extracted from the parachute ballistic data.

3.2.30. Item 30. Forward Travel Distance: Item 29 converted to distance using formula G.

$$\frac{\text{Ground Speed}}{1.78} = \frac{\text{(Forward Travel Distance)}}{\text{Forward Travel Time}}$$

3.2.31. Item 31. Stop Watch Distance: Ground distance in yards along track from a timing point to the CARP.

3.2.32. Item 32. Stop Watch Time: Item 31 converted to time, in seconds, using formula H.

$$\frac{\text{Groundspeed}}{1.78} = \frac{\text{Distance}}{\text{(Time)}}$$

3.2.33. Item 33. Usable Drop Zone Length: The distance in yards from the PI to the end of the DZ, minus the safety zone distance (if required) use formula I.

3.2.34. Item 34. Usable Drop Zone Time: Item 33 converted to time, in seconds, using formula H.

NOTES:

Never less than 3 seconds.

The planned interval between each parachutist's exit is one second, therefore, this value equates to the number (in addition to the first person out) of paratroopers who can safely be dropped in a single stick. This is equal to the total number of jumpers divided by the number of troop doors in use.

$$\frac{\text{Groundspeed}}{1.78} = \frac{\text{Distance}}{\text{(Time)}}$$

3.2.35. Item 35. Sight Angle: Extracted from AF Form 4018 (Reverse), Drop Zone Timing and Sight Angle Graph or derived from clinometer measurements. The C-17 uses a sight angle derived from tables in the mission computer and the visual angle from the pilot's and copilots" HUD.

Figure 3.1. Sample CARP Solution.

COMPUTED AIR RELEASE POINT COMPUTATIONS			DATE 1 Aug 01
NAVIGATOR'S NAME (Print) BENJAMIN, FRANK	CALL SIGN HUNT 31	ORGANIZATION 18 AS	NAVIGATOR'S SIGNATURE *Frank Benjamin*

	FACTORS		STANDARD AND MODIFIED COMPUTATIONS		
1	DROP ALTITUDE		*800*	*650*	*400*
2	TERRAIN ELEVATION	+	*560*	*560*	*560*
3	TRUE ALTITUDE		*1360*	*1210*	*960*
4	PRESSURE ALTITUDE VARIATION	+ A	*-80*	*0*	*70*
5	PRESSURE ALTITUDE		*1280*	*1210*	*1030*
6	CORRECTED DROP ALTITUDE	B	*795*	*645*	*395*
7	TERRAIN ELEVATION	+	*560*	*560*	*560*
8	INDICATED ALTITUDE		*1355*	*1205*	*955*
9	TRUE ALTITUDE TEMPERATURE		*+15*	*+15*	*+15*
10	IAS/CAS/EAS		*130/132*	*140/142*	*130/129*
11	TRUE AIRSPEED		*135*	*146*	*131*
12	RATE OF FALL		*17.4*	*26.2*	*20.0*
13	ADJUSTED RATE OF FALL	C	*17.7*	*26.5*	*20.3*
14	ALTITUDE ABOVE POINT OF IMPACT	D	*820*	*670*	*400*
15	VERTICAL DISTANCE	-	*180*	*540*	*370*
16	STABILIZATION ALTITUDE		*640*	*130*	*30*
17	TIME OF FALL	E	*36.2*	*4.9*	*1.5*
18	TIME OF FALL CONSTANT	+	*5.4*	*14.4*	*5.6*
19	TOTAL TIME OF FALL		*41.6*	*19.3*	*7.1*
20	BALLISTIC WIND		*250/10*	*190/10*	*120/10*
21	DRIFT EFFECT	F	*234*	*109*	*40*
22	DROP ALTITUDE WIND		*250/15*	*190/20*	*120/15*
23	MAGNETIC/TRUE COURSE		*040*	*022*	*302*
24	DRIFT CORRECTION		*-3*	*+2*	*0*
25	MAGNETIC/TRUE HEADING		*037*	*024*	*302*
26	GROUND SPEED		*148*	*165*	*146*
27	EXIT TIME			*4.6*	*4.2*
28	DECELERATION QUOTIENT	+		*1.5*	*2.7*
29	FORWARD TRAVEL TIME		*3.2*	*6.1*	*6.9*
30	FORWARD TRAVEL DISTANCE	G	*266*	*567*	*563*
31	STOP WATCH DISTANCE		*269*	*173*	*375*
32	STOP WATCH TIME	H	*3.2*	*1.9*	*4.6*
33	USABLE DROP ZONE LENGTH	I	*1000*	*500*	*600*
34	USABLE DROP ZONE TIME	H	*12.0*	*5.4*	*7.3*
35	RED LIGHT TIME (32 + 34)		*15.2*	*7.3*	*11.9*

PREFLIGHT ALTIMETER SETTING	*30.00*	*29.92*	*29.85*
DROP ZONE	*ROCK*	*COYLE*	*PUDGY*
SCHEDULED DROP TIME(S)	*2000*	*2100*	*2200*
LOAD	*PER*	*HE*	*CDS*
LOAD WEIGHT	*225*	*3500*	*1200*
PARACHUTE (*Type and number*)	*1xMC1-1*	*2xG-12D*	*1xG-12D*
FLIGHT STATION OF LOAD	*DOOR*	*540*	*737*

FORMULAS

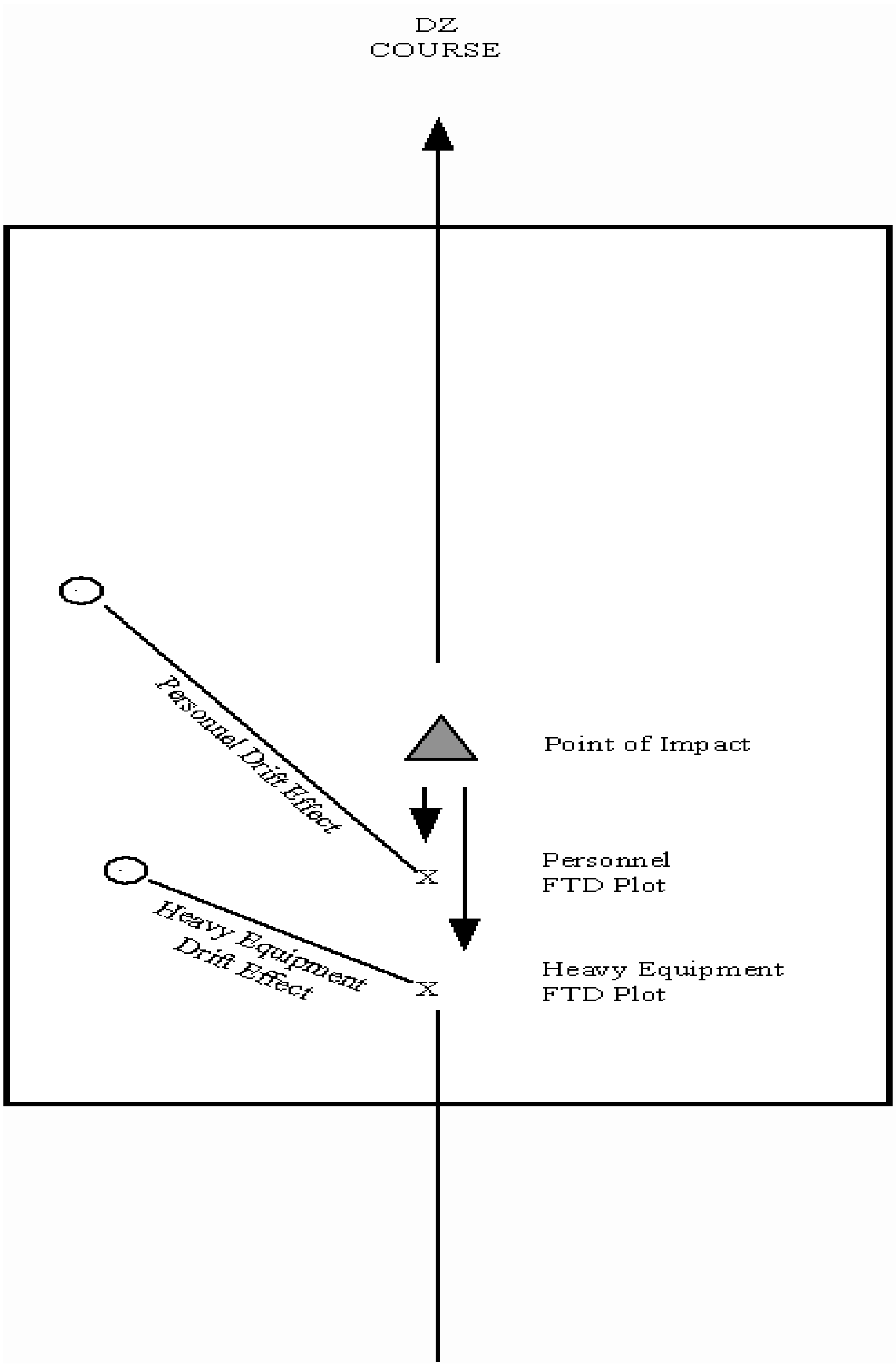
A	*29.92* / *29.85* / *+ 7*		*30.00* / *29.92* / *- 8*	
B	$\frac{\text{Temperature}}{\text{Pressure Altitude}} = \frac{\text{Drop Altitude}}{\text{(Corrected Drop Altitude)}}$ (ALTITUDE WINDOW)			
C	$\frac{\text{Average Temperature}}{\text{Average Pressure Altitude}} = \frac{\text{(Adjusted Rate of Fall)}}{\text{Rate of Fall}}$ (DENSITY ALTITUDE WINDOW)			
D	True Altitude	*1360*	*1210*	*960*
D	Minus Point of Impact Elevation	*540*	*540*	*560*
D	(Altitude above Point of Impact)	*820*	*670*	*400*
E	$\frac{\text{Adjusted Rate of Fall}}{\text{Stabilization Altitude}} = \frac{1.0}{\text{(Time of Fall)}}$			
F	$\frac{\text{Total Time of Fall}}{\text{1.78 (1.94 Mtr)}} = \frac{\text{(Drift Effect)}}{\text{Wind Speed}}$			
G	$\frac{\text{Groundspeed}}{\text{1.78 (1.94 Mtr)}} = \frac{\text{(Forward Travel Distance)}}{\text{Forward Travel Time}}$			
H	$\frac{\text{Groundspeed}}{\text{1.78 (1.94 Mtr)}} = \frac{\text{Distance}}{\text{(Time)}}$			
I	Usable DZ Remaining (PI to TE)	*1200*	*500*	*600*
I	Minus Safety Zone Distance	*200*	*0*	*0*
I	Usable Drop Zone Length	*1000*	*500*	*600*

CARD DATA	SURFACE WIND	*200/6*	*200/4*	*CALM*
CARD DATA	MEAN EFFECTIVE WIND	*-*	*200/7*	*-*
CARD DATA	ALTITUDE WIND	*250/10*	*230/15*	*180/4*
DROP DATA	BALLISTIC WIND USED (M) (I)	*I*	*I*	*I*
DROP DATA	GROUNDSPEED (C) (D) (S)	*C 145*	*C 161*	*C 147*
DROP DATA	DRIFT (C) (D) (S)	*C* 3^{O}*R*	*C* 0^{O}*R*	*C* 1^{O}*R*
DROP DATA	GREEN LIGHT TIME (S) (V)	*V*	*S 11.9*	*V*
DROP DATA	RED LIGHT TIME	*3 Sec*	*2 Sec*	*4 Sec*
RESULTS	TOT	*+.6*	*-.9*	*+1.1*
RESULTS	FORMATION POSITION (S) (V)	*V 1/1*	*S 1/2*	*V 2/1*
RESULTS	RAW CIRCULAR ERROR	*250/6*	*100/6*	*PI*
RESULTS	CORRECTED CIRCULAR ERROR	*250/6*	*87/7*	*PI*

AF FORM 4018, MAY 98 (LRA-V1) Replaces AMC FORM 512, Apr 93, which is obsolete.

3.3. Plotting Instructions. Using any drop zone mosaic, plot the drift effect upwind from the PI. Plot the forward travel distance back-track from the end of the drift effect vector, parallel to the run-in course. The end of this plot is the CARP. The reverse may also be used. Plot the forward travel distance back along DZ run-in axis. Then plot the drift effect vector from the end of forward travel distance vector. The end of this combined vector is the CARP (Figure 3.2). **Chapter 4** details other means of plotting CARPs.

Figure 3.2. Personnel and Heavy Equipment Plotting Diagram.



Chapter 4

ALTERNATIVE COMPUTED AIR RELEASE POINT SOLUTIONS

4.1. General . With the development of new equipment and procedures, additional methods of CARP solutions have been designed. Four modified CARP solutions and aids are the wind circle, Doppler Grid and Circle Overlay, and AF Form 4014. Alternate methods of updating CARP inflight, including techniques for wind analysis and T-CARP constant-angle timing, are included in this chapter. These solutions incorporate special techniques and tabulated data as aids to expedite the solution of the final CARP when close-in to the DZ.

4.1.1. All personnel involved in airdrop must realize aerial delivery using a CARP system is not an exact science. The system permits revisions close to the DZ and takes into considerations winds at various levels through which the parachute and load pass. When the aircrew member has a graphic presentation of the wind vectors and understands the characteristics of the parachutes used, they are better able to estimate the best release point.

4.1.2. Aircrew should be alert for changes in surface and altitude winds in the vicinity of the DZ. Often it is possible to spot a wind shear by observing a column of smoke. Information on winds at the different levels may not always be available. If not, the aircrew member still can use the best known drop altitude and surface winds.

4.1.3. Last minute CARP changes may preclude detailed study of the CARP track by the pilot. The aircrew member should be prepared to give directions and assist the pilot flying the aircraft in establishing the desired cross track drift offset.

4.2. AF Form 4013 Modified CARP Solution. Use the AF Form 4013, Modified CARP Solution, or MAJCOM approved software for modified CARP solutions. The AF Form 4013 is based on a forward travel computation and the formula D=KAV, where D is the drift effect in yards/meters, K is an average constant value for the type load being airdropped, A is the drop altitude in feet AGL divided by 1000, and V is the ballistic wind velocity in knots. The AF Form 4013 is designed primarily to provide all the data required for an airdrop mission computer (SCNS, INS, GPS, etc.). **Figure 4.1.**, provides an example of a filled-in AF Form 4013:

4.2.1. Items 1 through 8. Complete in accordance with paragraph **3.2.1.**through paragraph **3.2.8.**

4.2.2. Item 9. Type load/weight: Enter C, H, P, or T for type and number of chutes being used.

4.2.3. Item 10. Usable Drop Zone Length/Time: Usable length in yards/meters and seconds. Convert length to time using formula C.

NOTE:

Never less than 3 seconds

4.2.4. Item 11. PI Elevation: MSL elevation, in feet, of the PI. Extracted from the DZ survey or Assault Zone Availability Report (AZAR).

4.2.5. Item 12. Turn Delay: SCNS only. Number of seconds the computer will use to compute the delay between the trailing edge (TE) and the escape point (EP).

4.2.6. Item 13. DZ course: DZ centerline course referenced to true, magnetic, or grid and obtained from the DZ survey or AZAR.

4.2.7. Item 14. Rate of Fall: Extracted from the parachute ballistic data.

4.2.8. Item 15. Vertical distance: Extracted from the parachute ballistics data.

4.2.9. Item 16. Time of Fall Constant: Extracted from the parachute ballistics data.

4.2.10. Item 17. Exit Time: Extracted from the parachute ballistics data.

4.2.11. Item 18. Deceleration Quotient: Extracted from the parachute ballistics data.

4.2.12. Item 19. Forward Travel Time: Item 17 plus Item 18 or extracted from the parachute ballistics data.

4.2.13. Item 20. Forward Travel Distance: Item 29 converted to distance using formula G (AF Form 4018).

4.2.14. Item 21. Altimeter Setting: Expected DZ altimeter setting.

4.2.15. Item 22. True Altitude Temperature: Expected temperature in degrees Celsius at drop altitude.

4.2.16. Item 23. Preflight average drop wind direction and velocity. Used to compute drift effect.

4.2.17. Item 24. Drift Effect: Distance in yards/meters computed using formula F (AF Form 4018).

4.2.18. Item 25. Blank space for local use. May be used for green light timing, sight angle value, wind circle values, or any other information considered important by the individual aircrew member.

Figure 4.1. AF Form 4013.

MODIFIED CARP SOLUTION			DATE (Day, Month, Year) 1 Aug 02
NAVIGATOR'S NAME (Print) JONES, BRIAN	CALL SIGN EVEN 32	ORGANIZATION 41 AS	NAVIGATOR'S SIGNATURE *Brian D. Jones*

	FACTORS		STANDARD AND MODIFIED COMPUTATIONS								
1	DROP ALTITUDE		835	400	950	14	RATE OF FALL		16.8	19.1	27.1
2	TERRAIN ELEVATION	+	2970	2970	2970	15	VERTICAL DISTANCE		180	320	540
3	TRUE ALTITUDE		3805	3370	3920	16	TIME OF FALL CONSTANT		5.4	3.7	14.4
4	PRESSURE ALTITUDE VARIATION	+ A	-80	0	70	17	EXIT TIME		3.2	4.1	4.6
5	PRESSURE ALTITUDE		3275	3370	3990	18	DECELERATION QUOTIENT	+	✓	2.9	1.5
6	CORRECTED DROP ALTITUDE	B	815	390	925	19	FORWARD TRAVEL TIME		3.2	7.0	6.1
7	TERRAIN ELEVATION	+	2970	2970	2970	20	FORWARD TRAVEL DISTANCE	G	237y	501y	411y
8	INDICATED ALTITUDE		3785	3360	3895	21	ALTIMETER SETTING		30.00	29.92	29.85
9	TYPE LOAD/WEIGHT		PRB/225	CDS/1600	HE/3700	22	TRUE ALTITUDE TEMPERATURE		+16	+15	+14
10	USABLE DROP ZONE LENGTH/TIME (SEC)		300/	500/	500/	23	BALLISTIC WIND		030/10	360/15	290/20
11	PI ELEVATION		2970	2970	2970	24	DRIFT EFFECT	F	250y	90y	285y
12	TURN DELAY (SEC)		60	NA	NA	25	200 YARDS =		8 KTS	34 KTS	14 KTS
13	MAG/TRUE COURSE		129	129	129						

AF Form 4013 REPLACES AMC FORM 511, JUN 92

4.3. AF Form 4014, Grid Overlay Plotter, Solution.

4.3.1. Description. AF Form 4014 is a clear plastic overlay depicting both grid plotter and generic wind circle cut-outs. The generic wind circle contains two rings scaled to match both the timing graph and the sight angle tables on AF Form 4018 (Reverse). The outer ring is marked with azimuth lines at 30 degrees intervals. At the center of the inner circle is a dot used to position the wind circle correctly on AF Form 4018 (Reverse).

4.3.2. Use of the grid plotter is prescribed later in this instruction. To use the wind circles, clip out along the dotted line. The loose wind circles can now be overlaid on the AF Form 4018 (Reverse). Using either side of the AF Form 4018, measure FTD back from the depicted PI. Place the dot in the center of the wind circles on this point. Turn the wind circles so the surveyed DZ course (on the circles) is overlaid along the DZ axis (depicted on the AF Form 4018). Magnetic or true course can be used depending on whether the aircrew member is using magnetic or true winds to plot the CARP Plot the drift effect along the wind azimuth. This is your CARP. Converting the CARP to an elapsed time or a sight angle is discussed in paragraph **4.4.**

NOTES:

The wind circles are calibrated to multiples of 400 yards on the timing graph and multiples of 200 yards on the sight angle graph. Use caution when interpolating drift effect.

Use formula H (AF Form 4018, CARP Computation). The wind circle size can be converted to a wind speed for ease of inflight plotting.

4.4. Inflight use of AF Form 4018 (Reverse). AF Form 4018 (Reverse) allows for inflight CARP determination. This form depicts a generic drop zone mosaic modified with the addition of a timing graph. The from is designed to be used with the wind circle cut-out from AF Form 4014.

4.4.1. Timing Graph.

4.4.1.1. Plot the PI location on the depicted DZ axis so the bottom of the DZ grid equates to the selected timing point (distance from bottom of grid to block letter equals distance from selected timing point to surveyed PI).

4.4.1.2. Plot the CARP in accordance with para. **4.3.**

4.4.1.3. Along a line perpendicular to the DZ axis, move the CARP to the column on the right equating to the aircraft groundspeed.

4.4.1.4. Proceed diagonally along the timing lines to obtain the stopwatch timing. Interpolate between whole seconds. Result is the elapsed time from the selected timing point to the release point.

NOTE:

If the AF Form 4014 overlay is not available, plot the drift effect from the PI location and determine a raw time in accordance with **4.4.1.3.** and 4.4.1.4. above. Subtract forward travel time from raw time to obtain stopwatch time.

4.5. Wind Circle Solution. The wind circle solution is designed to permit the aircrew member to evaluate wind conditions very close to the DZ and at levels other than drop altitude. All work in constructing the wind circle is done on the ground. The drift effect for three or more wind velocities (usually 10, 20 and 30 knots) is drawn on the DZ depiction centered on the point of impact, or on the FTD plot. Wind circles may also be constructed using any convenient distance increment (usually 200 yards). A true or magnetic north arrow is drawn through the center of the circle with azimuth lines, normally at 30 degree increments, around the circle to facilitate speedy plotting of wind directions. In-flight, the aircrew member determines winds, plots them on the wind circle, and applies FTD (if required) to provide an instantaneous CARP. It is possible to completely re-evaluate the CARP inside the one-minute advisory.

4.5.1. Preflight

4.5.1.1. Select a properly scaled DZ chart, photograph or drawing. The wind circle may be drawn on clear acetate or similar material for reproduction. These reproductions may be attached to DZ photos for in-flight use.

4.5.1.2. Complete the AF Form 4018. TTF is needed to construct the wind circle, except when constant wind circle spacing is used.

4.5.1.3. Determine the drift effect for a 10 knot wind using the formula:

$$\frac{\text{TTF}}{1.78} = \frac{\text{(Drift Effect)}}{10}$$

4.5.1.4. Draw circles on the DZ depiction representing the drift effect for selected wind velocities up to 40 knots. Wind circles should be centered on the PI. It may be centered on the FTD plot, but an error is induced along the run-in axis for any in-flight change from the original preflight value of groundspeed used to make the plot. Even though small errors (2.8 yards each second of FTT for each 5 knots change in preflight CARP groundspeed) are induced by positioning the wind circles on the FTD plot, such errors may be acceptable in relation to possible plotting and computation errors made possible by attempting to do so inflight.

4.5.1.5. Draw azimuth lines from the PI or FTD plot outward to the outer circle each 30 degrees or selected increment. Label each with the appropriate value. Magnetic values are desirable since DZCT winds are passed as magnetic values.

4.5.1.6. Label the DZ depiction or acetate overlay with the constants used to construct the wind circles; i.e., type parachute, load weight, TTF, or size of constant wind circles used. The aircrew member should always recompute the CARP before each mission to verify the wind values.

4.5.1.7. Plot the preflight drift effect from the PI or FTD plot.

4.5.1.8. Measure the distance from the end of the drift effect plot or the CARP to the timing line and convert to time using the preflight groundspeed. If the wind circle is centered on the FTD plot, the result is the timing point time. If the wind circle is centered on the PI, subtract the FTT from this time. The result is the timing point time.

4.5.2. In-Flight Wind Determination.

4.5.2.1. The wind circle allows aircrew members to average and plot a number of different winds with relative ease and speed. These include surface, intermediate, mean-effective, drop altitude, forecast, and estimated winds. The aircrew member is encouraged to obtain and plot several winds from different sources in order to get the best picture possible of actual wind conditions. The decision on which wind or combination of winds to use is up to the individual. Aircrew members must insure they compute drop altitude drift and groundspeed for line up and timing. During combat conditions, drift effect is normally plotted based on an average of surface wind indications and navigation computer readouts.

4.5.3. Sample Problem:

4.5.3.1. **Figure 4.2.** was constructed using the following information from an AF Form 4018 computation:

4.5.3.1.1. Parachute - T-10.

4.5.3.1.2. Weight - 250 lbs

$$\frac{51.6}{1.78} = \frac{(289)}{10}$$

4.5.3.1.3. TTF - 51.6 secs

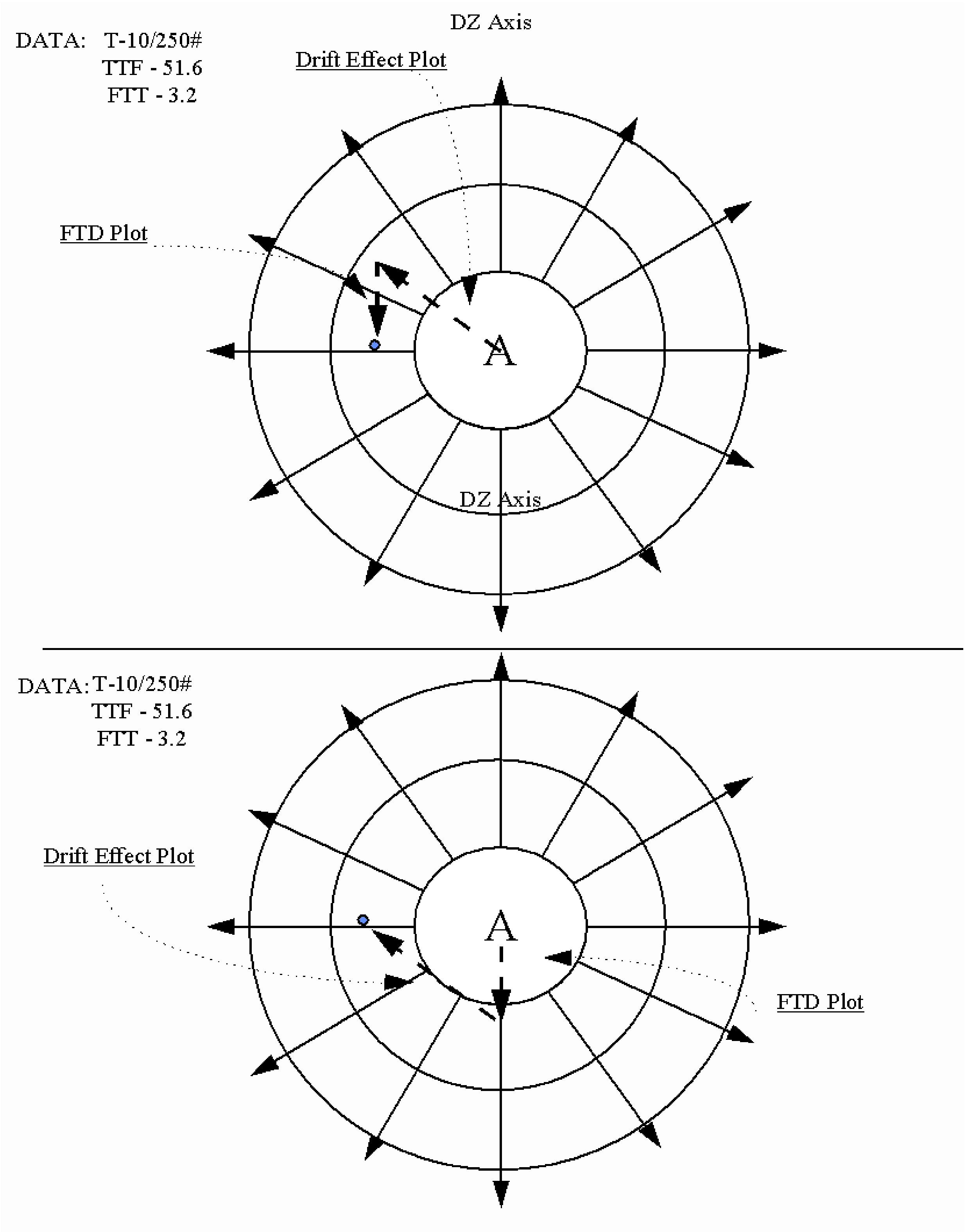
4.5.3.1.4. FTT - 3.2 secs

4.5.3.1.5. Ballistic wind - 200^{o}/20 knots

4.5.3.1.6. Groundspeed - 110 knots

4.5.3.2. The drift effect for a 10 knot wind equals 289 yards.

Figure 4.2. Wind Circle Sample.



4.6. Grid Overlay Solution. The grid overlay solution is a mathematically derived, visual presentation for rapid computation of a CARP in-flight. Its use is preceded by completing the CARP computations, AF Form 4018. Small deviations from preflight values computed are acceptable. Wind information (GS and drift), obtained at and below drop altitude, can be used to compute the in-flight CARP. After the final slowdown and arrival at drop altitude, the CARP can be reconfirmed or adjusted for winds over the DZ. The basic idea of the solution is to provide the aircrew member an instantaneous CARP for any combination of head/tail winds and drift effect.

4.6.1. Preflight:

4.6.1.1. Complete the AF Form 4018. TTF, FTT, and aircraft TAS are needed to construct the overlay.

4.6.1.2. Determine the cross track drift effect offset, in yards, for two degrees of drift using the "AC" constant, see **Figure 4.3.** for the values, and the formula:

$$\frac{\text{Chord("AC")}}{1.78} = \frac{(2^{o}\ \text{Offset Distance})}{\text{TTF}}$$

(1.94 for meters)

4.6.1.3. Determine the head/tail wind effect distance, in yards, for 5 knots of wind using the formula:

$$\frac{5}{1.78} = \frac{(\text{Head/Tail Wind Distance})}{\text{TTF + FTT}}$$

NOTE: FTT is added to compensate for changes in the forward travel vector caused by changes in groundspeed.

4.6.1.4. Select a properly scaled DZ depiction to be used for the airdrop. Insure that all plots use the corresponding scale. Grid overlays may be drawn on clear acetate or similar material for reproduction. These reproductions may be attached to DZ photos for in-flight use.

4.6.1.5. Plot the FTD based on drop TAS using the formula:

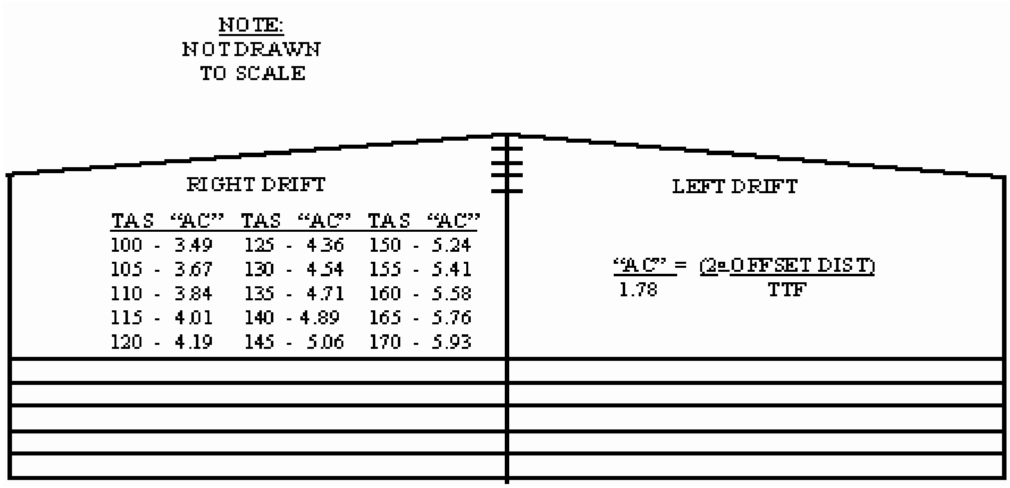
$$\frac{\text{TAS}}{1.78} = \frac{(\text{FTD})}{\text{FTT}}$$

4.6.1.6. Starting with the FTD plot, mark the desired number of 5 knot head/tail wind distance fore and aft of this plot on the run-in axis. A maximum wind circle may be drawn to determine the size desired; however, five in each direction normally are drawn. Graduations (see (A), **Figure 4.4.**) are provided to measure the distance between plots and leading edge of the grid overlay plotter as a guide for drawing the groundspeed lines.

NOTE: Drift angle is accurate only at drop airspeed. The 5kt groundspeed increments represent differences from "CARPed" true airspeed. When off true airspeed a reasonably accurate correction can be made by applying planned and actual true airspeed differences to the actual groundspeed.

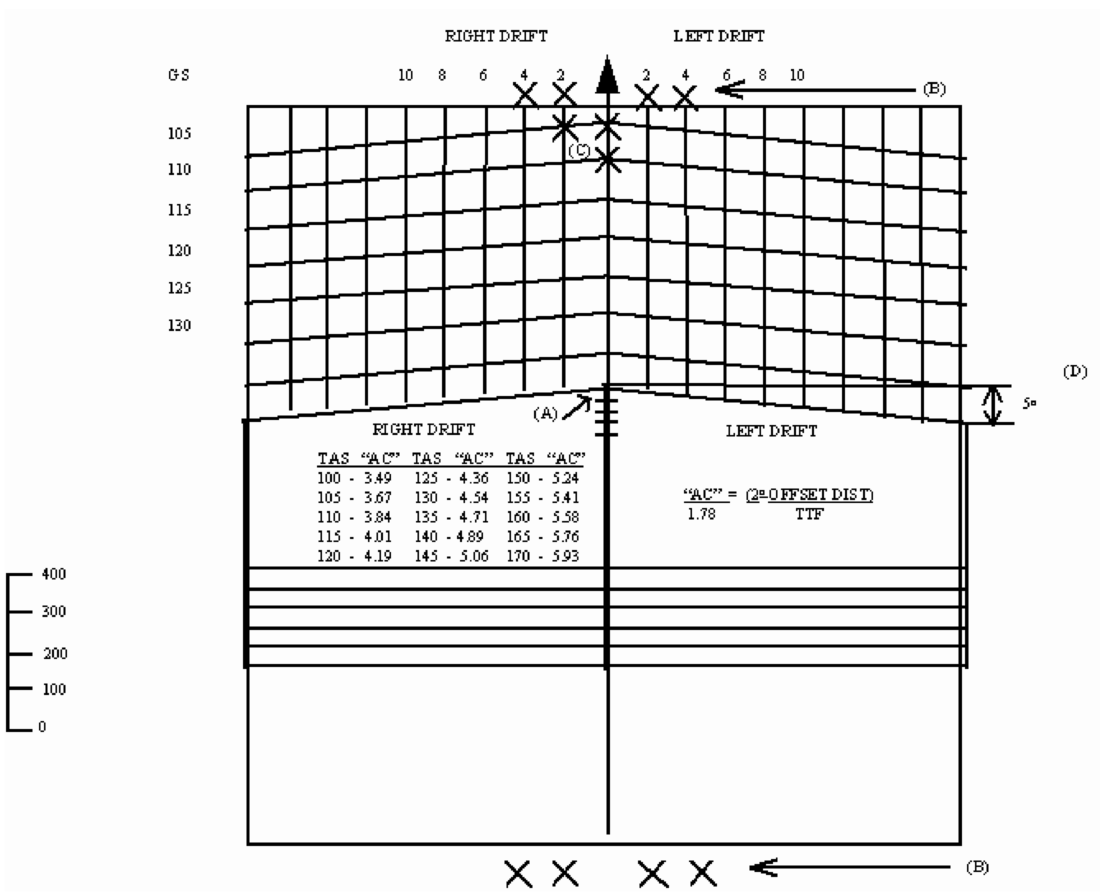
4.6.1.7. On a line perpendicular to the run-in axis and running through one of the head/tail wind plots, mark the desired number, normally five, of the 2^{o} offset distances on each side of the axis. The graduations/lines, (see (B), **Figure 4.4.**) are provided for measuring and drawing the lines.

Figure 4.3. AF Form 4014, GRID Overlay Plotter.



TTF=51.6
FTT=3.2
TAS=130

Figure 4.4. GRID Overlay Sample.



4.6.1.8. Complete the grid overlay, as shown in **Figure 4.4.**, using the grid overlay plotter.

NOTE: The grid overlay may be drawn using dividers to mark all plots (see (C), **Figure 4.4.**), and the standard air navigation plotter to draw in the lines. Groundspeed lines are 5^{o} from the perpendicular to the run-in axis (see (D), **Figure 4.4.**).

4.6.1.9. The line through the FTD plot is a zero head/tail wind effect line and will be labeled with the computed drop TAS (for any CARP on this line, GS = TAS) or with "0" head/tail wind effect. Succeeding lines will be labeled with the appropriate groundspeed, in 5 knot increments, or with the appropriate head/tail wind effect (i.e., -5, -10, +5, +10, etc.).

NOTE: Labeling head/tail wind effect lines with groundspeed increments normally is the most desirable. It eliminates conversion of Doppler readouts into TAS - GS differences, thereby making last second changes to the timing problem simple by having to monitor only a single instrument.

4.6.1.10. Label each parallel drift offset line with the appropriate offset value. Care must be taken to label with the correct +/- drift correction (left drift to the right of the DZ and vice versa).

4.6.1.11. Label the grid overlay with the constants used in its construction; Type parachute, load weight, TTF, FTT, and TAS.

4.6.1.12. Insure the preflight drift effect is plotted from a FTD plot using preflight groundspeed.

4.6.2. Sample Problem. Information used in drawing the grid overlay shown in **Figure 4.4.**

4.6.2.1. Constants:

4.6.2.1.1. Parachute - T-10.

4.6.2.1.2. Load Weight - 250 lbs.

4.6.2.1.3. TTF - 51.6 secs.

4.6.2.1.4. FTT - 3.2 secs.

4.6.2.1.5. TAS - 130 knots.

4.6.2.2. Cross Track Drift Offset - 132 yards.

$$\frac{4.54}{1.78} = \frac{(132)}{51.6}$$

4.6.2.3. Head/Tail Wind Distance - 154 yards.

$$\frac{5}{1.78} = \frac{(154)}{54.8}$$

4.6.2.4. Forward Travel Distance - 234 yards.

$$\frac{130}{1.78} = \frac{(234)}{3.2}$$

4.6.3. In-flight Use:

4.6.3.1. The aircrew member will determine from all available sources the effective wind acting upon the parachutist/load from drop altitude to ground level. It will be necessary to convert this mean wind to drift and groundspeed values. The intersection of these two values is the CARP.

4.6.3.2. The aircrew member should be aware that final wind drift values (as read from the grid overlay) will not necessarily represent the drift value used to determine the heading to fly at release. Also, the direct groundspeed readouts of navigation computer systems may not correspond to the values which affect the object dropped.

4.6.3.3. One disadvantage of the grid overlay, when used alone, is the time required to convert the wind selected into drift and groundspeed values; however, it does interface with the close-in solution of the CARP using direct navigation computer system readouts, especially in solving the timing problem.

4.6.3.4. Once the CARP is plotted, measure the distance from the timing line to the CARP and convert it to time (using formula H on the AF Form 4018) to determine timing point time.

4.7. Modified Grid Overlay Solution. The modified grid overlay combines the grid overlay with the wind circle method. It allows the aircrew member to take into account the navigation system supplied drift and groundspeed, as well as other wind information such as DZCT MEW, surface winds, etc., and project them on the DZ depiction. A rapid determination of the CARP can be made from this graphic presentation, well within the one-minute advisor.

4.7.1. Preflight:

4.7.1.1. Select a properly scaled DZ chart, photo or drawing.

4.7.1.2. Compute a CARP using preflight wind information and the standard computer solution.

4.7.1.3. Construct the grid overlay IAW paragraph **4.6.**

4.7.1.4. Draw the wind circle IAW paragraph **4.5.** The wind circle is centered on the FTD plot used for the grid overlay.

NOTE:

An option is to make the wind circle an ellipse. Based on the groundspeed increments at 6 and 12 o'clock and the wind circles at 3 and 9 o'clock. This method is the most accurate for drops with high forward travel times

4.7.1.5. Plot the preflight ballistic wind using preflight FTD.

4.7.1.6. Convert the distance from the CARP to the timing point to time using preflight groundspeed. Enter this distance and time in the AF Form 4018, Items 33 and 34.

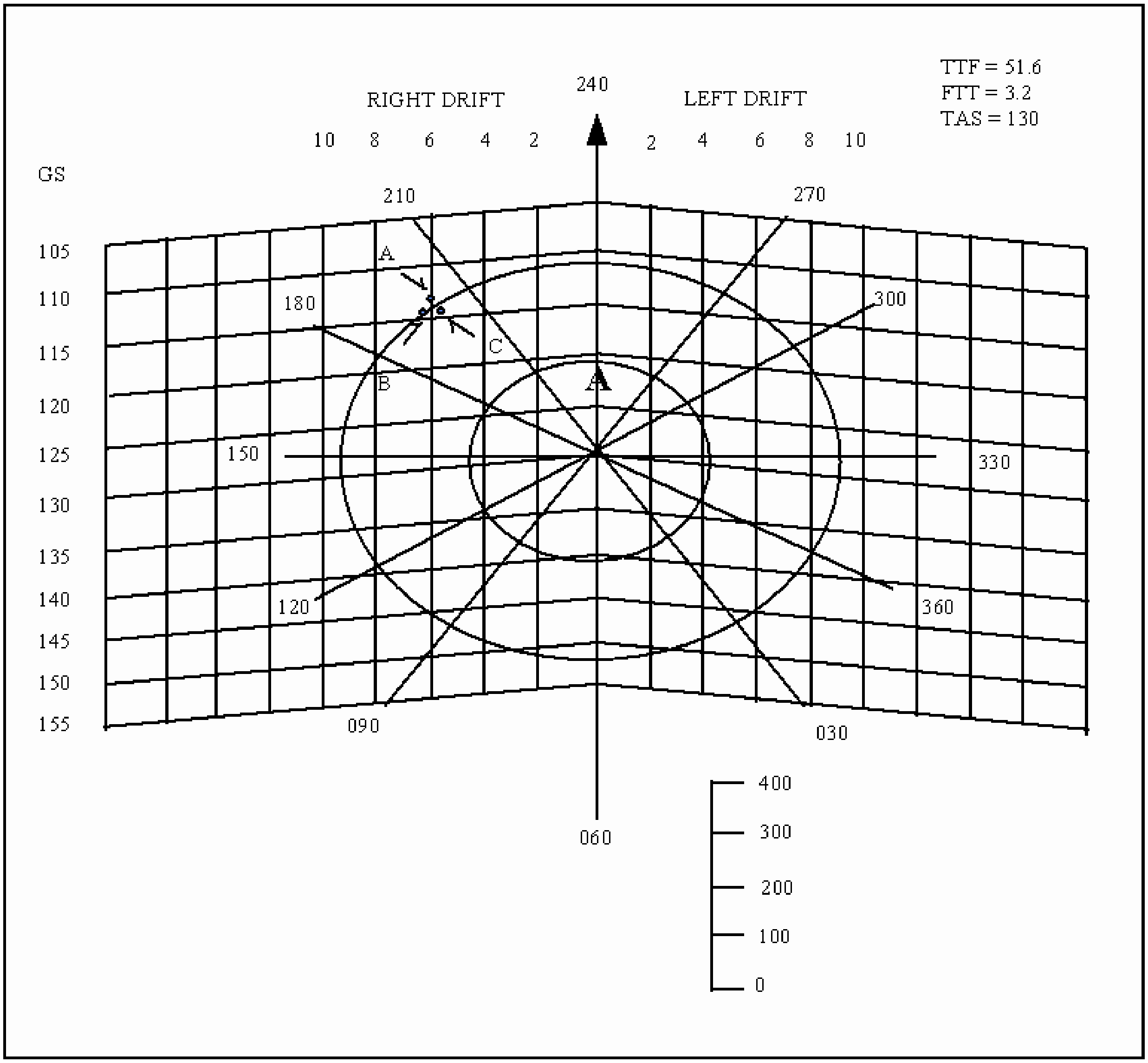
4.7.1.7. The CARP may be plotted using one of three methods:

4.7.1.7.1. Plot the drift effect from the FTD plot computed using preflight (110 knots) groundspeed (see (A), **Figure 4.5.**).

4.7.1.7.2. Plot the ballistic wind azimuth (200^{o}) and velocity (20 knots) on the wind circle (see (B), **Figure 4.5.**).

4.7.1.7.3. Plot ballistic wind drift (- 6^{o}) and the groundspeed (114 knots) values using the grid overlay (see (C), **Figure 4.5.**).

Figure 4.5. Modified GRID Overlay Sample.



NOTE: As indicated, these plots will not necessarily fall at the same point. The only time a common CARP occurs is when a direct 25 knot head or tail wind is used.

4.7.1.8. To reduce the clutter of the numerous lines drawn on the DZ depiction, it may be desirable to omit the circles or to plot the Grid and circles in different colors. A quick method to plot wind direction and velocity is available by using the dividers to arc the distance/velocity measured on the run-in axis (the interval between grid overlay groundspeed lines equals five knots of velocity) to the appropriate azimuth line. Omitting alternating grid overlay line will also reduce clutter, yet provide a usable solution to the wind plotting problem.

4.7.1.9. See **Figure 4.5.** for a completed solution. Use the same data as paragraph **4.6.2.**

4.7.2. In-flight:

4.7.2.1. Plot navigation system drift and groundspeed, surface winds, MEW, and any other available wind information. Evaluate the winds to determine the CARP you plan to use.

4.7.2.2. Compute timing point distance using the current or projected groundspeed.

4.8. Timing Graph Solution. The timing graph combines the wind circle and grid overlay methods with a groundspeed-time graph. This provides the aircrew member a form upon which a PI-Timing point configuration for any DZ may be constructed. The in-flight CARP can be plotted to allow the aircrew member to extract a final timing point time quickly. The groundspeed-time graph (**Figure 4.6.**, right hand side of figure) may be duplicated to use in conjunction with a DZ chart/photo, provided it is constructed using the same scale. This form may be best used for use with timing panels or lights. This does not restrict its use when timing from any prominent surface feature.

4.8.1. Preflight:

4.8.1.1. Plot the point of impact the required number of yards away from the timing line. The line may be an extension of timing light/panels or a selected geographical timing point.

4.8.1.2. Complete wind circle, grid overlay or modified grid IAW paragraphs **4.5.**,**4.6.** or **4.7.**

4.8.1.3. Predominate DZ features may be annotated to aid line-up.

4.8.2. In-flight:

4.8.2.1. Timing point time may be obtained by plotting the drift effect from the point of impact, proceeding horizontally to groundspeed, then diagonally to timing point time. Subtract the forward travel time to obtain actual timing point time. The procedure is recommended since it minimizes the forward travel distance error induced by the difference in preflight and actual groundspeed.

4.8.2.2. Plot the CARP based on FTD and drift effect, proceeding horizontally to groundspeed, then diagonally to timing point time in seconds.

NOTE: A negative number indicates a CARP prior to the timing line.

4.8.2.3. The timing graph may be used to compute UDZL.

4.8.3. Sample Problem:

4.8.3.1. Given:

4.8.3.1.1. FTT - 3.2 secs

4.8.3.1.2. TAS - 130 knots

4.8.3.1.3. GS - 110 knots

4.8.3.1.4. W/V - 200^{o}/20 kts

4.8.3.1.5. Drift Effect - 580 yards

4.8.4. The CARP is plotted from the forward travel distance plot and drift effect from the point of impact. The offset is the same for both methods, 370 yards left and 16.9 seconds is the resultant timing point timing. If the FTD is not plotted, a time of 20.1 seconds would be extracted from the chart. When the FTT of 3.2 seconds is subtracted, the resulting solution is the same 16.9 seconds as in the first method. The wind circle, grid overlay or modified grid from the point of impact or FTD plot was not shown to avoid confusion.

4.9. Other Timing Graphs. Timing graphs may be constructed to be used in conjunction with other types of drops using a specific parachute. FTT is the governing factor. **Figure 4.6.** is an example for personnel (T-10 parachute) which incorporates FTT to provide the aircrew member a final timing point time readout once drift effect is plotted.

4.9.1. Construction.

4.9.1.1. Refer to **Figure 4.6.**. A FTT of 3.2 seconds was used to determine the points in constructing the one second timing line. Use the formula:

$$\frac{\text{GS (90 and 190)}}{1.78} = \frac{\text{(Distance)}}{4.2(3.2 + 1 \text{ sec})}$$

4.9.1.2. Plot and join these distances (212 and 448 yards) on the graph. Repeat procedures for each additional second; i.e., 5.2, 6.2, etc., or find the yardage for a one second interval using the following formula, then plot succeeding lines:

$$\frac{\text{GS(90 and 190)}}{1.78} = \frac{\begin{matrix}\text{(Distance)} \\ \text{[51 and 107 yds]}\end{matrix}}{1}$$

4.9.1.3. Plot distances as applicable to complete the GS/Time graph. Use the same procedure and applicable FTT when constructing a graph for other type parachutes.

4.9.2. Preflight. Complete graph using the desired modified CARP solution. Insure the following rules are followed:

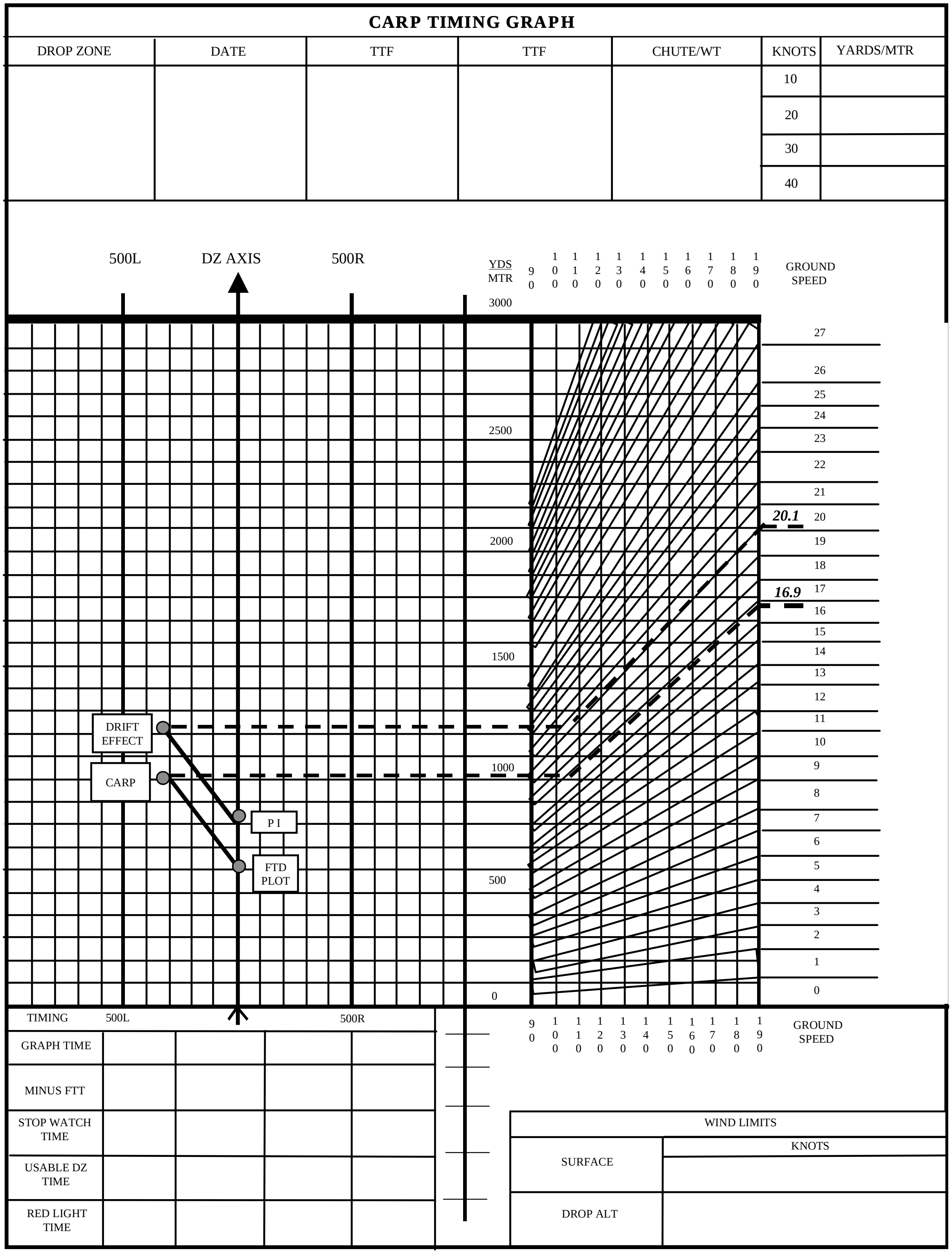
4.9.2.1. Wind Circle - Must be centered on the PI.

4.9.2.2. Grid Overlay - The preflight TAS line is plotted through the PI. Use the following formula instead of the formula in paragraph **4.4.1.3.**; i.e., do not add FTT to TTF in that formula:

$$\frac{5}{1.78} = \frac{\text{(5 Knot Head/Tail Wind Distance)}}{\text{TTF}}$$

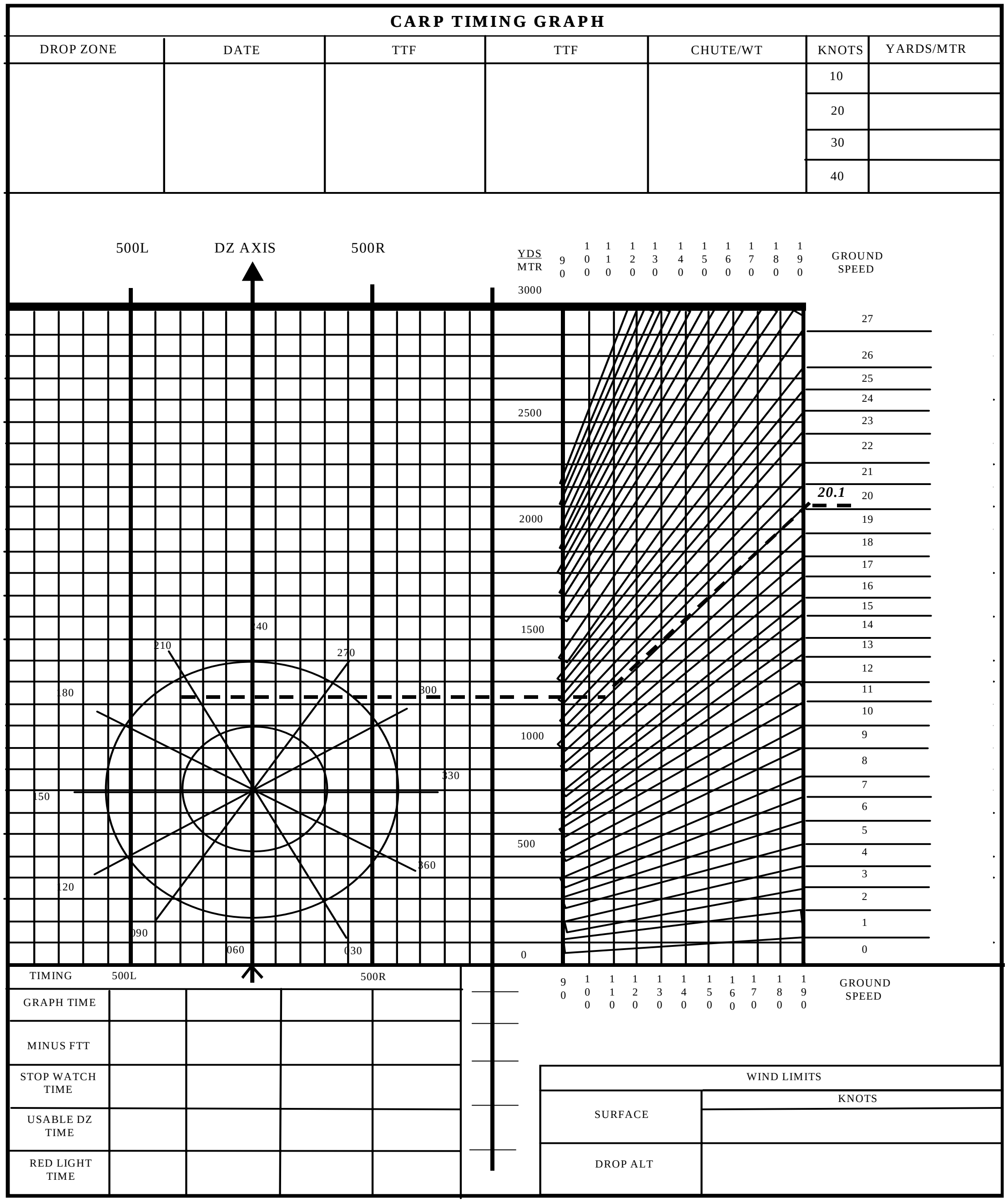
4.9.3. In-flight. The same data as in paragraph **4.8.3.**, above was used in this example. Plot drift effect, proceed vertically to the GS (at release) line, then diagonally to the final timing point time. This graph may be used to convert distance, timing point to the drift effect plot, from a separate DZ depiction provided the same rules as in paragraph **4.9.2.**, above, are followed on the depiction. Distance may also be converted to time, using this graph, when used in conjunction with a grid overlay drawn on the DZ depiction. To do so, measure the distance from the CARP to the timing point, extract timing point time from the graph and add FTT.

Figure 4.6. Timing Graph Sample.



AF FORM 4018, MAY 98 (EF-V1) ***(REVERSE)***

Figure 4.7. Personnel Timing Graph Sample.



AF FORM 4018, MAY 98 (EF-V1) ***(REVERSE)***

4.10. Sight AngleTechniques. Another variation of timing graphs is shown in this example problem:

4.10.1. Complete AF Form 4018 per **Chapter 3** given the following:

4.10.1.1. Drop altitude - 650 feet AGL

4.10.1.2. Highest terrain elevation on DZ - 1443 feet MSL

4.10.1.3. True altitude - 2093 feet MSL

4.10.1.4. PI elevation - 1443 feet MSL

4.10.1.5. Load - SATB-H

4.10.1.6. Wind - 358/08

4.10.1.7. Groundspeed - 162 Knots

4.10.1.8. FTT - 1.9 Seconds

4.10.1.9. Usable DZ length - 1200 yards

4.10.1.10. Determine altitude above the PI using AF Form 4018 block 14.

4.10.1.11. Determine aircraft deck angle from appropriate weapon system technical order or aircraft instruction. For this example, assume two degrees.

4.10.1.12. Determine timing point. For this example, assume the PI is the timing point.

4.10.1.13. Use the formula - Sighting Distance = D = (TAN @) x (A/3)

D = Distance measured directly below the flight deck at the moment the designated target intersects an internal reference point.

@ = Angle of inclination from flight deck to designated target

A = Absolute altitude in feet AGL above the designated target

NOTE: Angle @, is measure using a clinometer or is specified through established techniques for each aircraft (i.e., the technique for the C-141B is to use an angle of 75.5 degrees when the deck angle is zero degrees and the top of the aircrew member's head is against the center overhead panel and is sighting over the Flight Command Repeater (FCR) box).

4.10.1.14. Given a C-141B with a two degree deck angle and using the formula in paragraph 4.10.4, we solve for the following: D = (TAN (75.5 +2)) x (650/3) = 977 yards.

Figure 4.8. Sight Angle Timing Graph CARP Sample.

COMPUTED AIR RELEASE POINT COMPUTATIONS			DATE 1 Aug 01
NAVIGATOR'S NAME (Print) SCHWAB, GREG	CALL SIGN FLEX 12	ORGANIZATION 59 ALS	NAVIGATOR'S SIGNATURE Greg Schwab

	FACTORS		STANDARD AND MODIFIED COMPUTATIONS		
1	DROP ALTITUDE		*650*		
2	TERRAIN ELEVATION	+	*1443*		
3	TRUE ALTITUDE		*2093*		
4	PRESSURE ALTITUDE VARIATION	+ A	*-280*		
5	PRESSURE ALTITUDE		*1813*		
6	CORRECTED DROP ALTITUDE	B	*672*		
7	TERRAIN ELEVATION	+	*1443*		
8	INDICATED ALTITUDE		*2115*		
9	TRUE ALTITUDE TEMPERATURE		*+2*		
10	IAS/CAS/EAS		*150*		
11	TRUE AIRSPEED		*152*		
12	RATE OF FALL		*23.8*		
13	ADJUSTED RATE OF FALL	C	*23.9*		
14	ALTITUDE ABOVE POINT OF IMPACT	D	*650*		
15	VERTICAL DISTANCE	-	*0*		
16	STABILIZATION ALTITUDE		*650*		
17	TIME OF FALL	E	*27.2*		
18	TIME OF FALL CONSTANT	+	*0*		
19	TOTAL TIME OF FALL		*27.2*		
20	BALLISTIC WIND		*350/08*		
21	DRIFT EFFECT	F	*122*		
22	DROP ALTITUDE WIND		*350/10*		
23	MAGNETIC/TRUE COURSE		*172*		
24	DRIFT CORRECTION		*-0*		
25	MAGNETIC/TRUE HEADING		*172*		
26	GROUND SPEED		*162*		
27	EXIT TIME		*-*		
28	DECELERATION QUOTIENT	+	*-*		
29	FORWARD TRAVEL TIME		*1.9*		
30	FORWARD TRAVEL DISTANCE	G	*173*		
31	STOP WATCH DISTANCE		*664*		
32	STOP WATCH TIME	H	*7.1*		
33	USABLE DROP ZONE LENGTH	I	*1200*		
34	USABLE DROP ZONE TIME	H	*12.2*		
35	RED LIGHT TIME (32 + 34)		*20.3*		

PREFLIGHT ALTIMETER SETTING	*30.20*		
DROP ZONE	*ROCK*		
SCHEDULED DROP TIME(S)	*0100Z*		
LOAD	*STAB-H*		
LOAD WEIGHT	*15#*		
PARACHUTE (*Type and number*)	*68 in PILOT*		
FLIGHT STATION OF LOAD	*Bomb Door*		

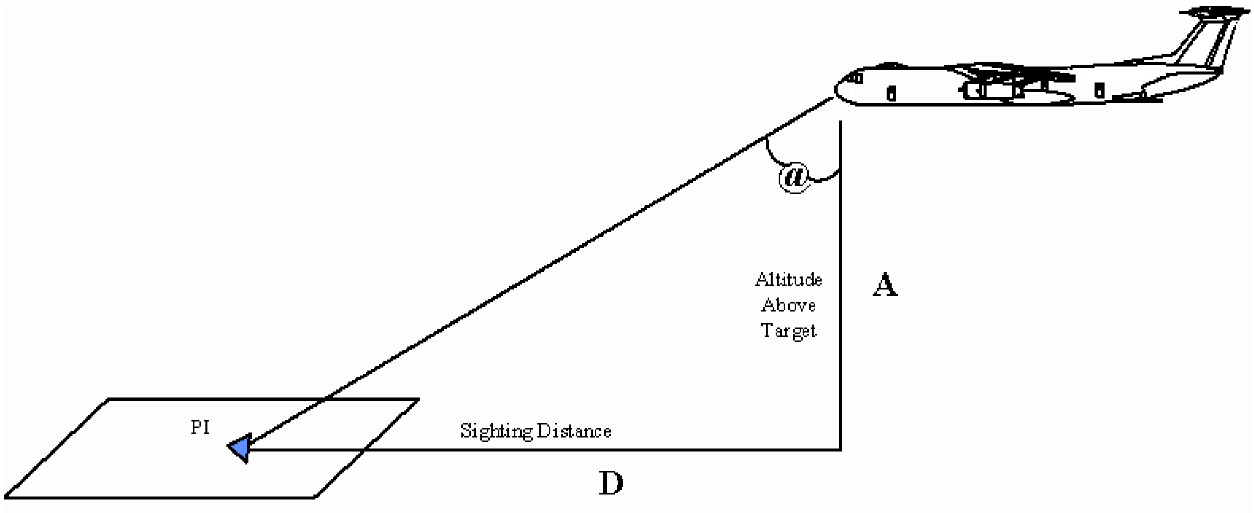
FORMULAS

A	*29.92* / ____	*30.20* / *29.92* = *- 28*
B	Temperature / Pressure Altitude = Drop Altitude / (Corrected Drop Altitude) *(ALTITUDE WINDOW)*	
C	Average Temperature / Average Pressure Altitude = (Adjusted Rate of Fall) / Rate of Fall *(DENSITY ALTITUDE WINDOW)*	
D	True Altitude	*2093*
	Minus Point of Impact Elevation	*1443*
	(Altitude above Point of Impact)	*650*
E	Adjusted Rate of Fall / Stabilization Altitude = 1.0 / (Time of Fall)	
F	Total Time of Fall / 1.78 (1.94 Mtr) = (Drift Effect) / Wind Speed	
G	Groundspeed / 1.78 (1.94 Mtr) = (Forward Travel Distance) / Forward Travel Time	
H	Groundspeed / 1.78 (1.94 Mtr) = Distance / (Time)	
I	Usable DZ Remaining (PI to TE)	*1200*
	Minus Safety Zone Distance	*0*
	Usable Drop Zone Length	*1200*

CARD DATA	SURFACE WIND			
	MEAN EFFECTIVE WIND			
	ALTITUDE WIND			
DROP DATA	BALLISTIC WIND USED (M) (I)			
	GROUNDSPEED (C) (D) (S)			
	DRIFT (C) (D) (S)			
	GREEN LIGHT TIME (S) (V)			
	RED LIGHT TIME			
RESULTS	TOT			
	FORMATION POSITION (S) (V)			
	RAW CIRCULAR ERROR			
	CORRECTED CIRCULAR ERROR			

AF FORM 4018, MAY 98 (LRA-V1) Replaces AMC FORM 512, Apr 93, which is obsolete.

Figure 4.9. Aircraft Sight Angle Timing Graph Diagram.



4.10.2. Plotting instructions for timing graph:

4.10.2.1. The bottom line of the grid represents the timing reference point.

4.10.2.2. Plot the sighting distance (D from paragraph **4.10.1.4.**) along the DZ axis from the bottom of the graph in **Figure 4.10.** towards to the top of the graph.

4.10.2.3. Draw wind circles (based on TTF and formula F on the AF Form 4018 in 10, 20, 30 and 40 increments) from the point determined by paragraph **4.10.2.2.** (**Figure 4.11.**)

4.10.2.4. Plot the CARP based on the preflight winds (**Figure 4.12.**)

4.10.2.5. Measure from the CARP to the right until it intersects with the preflight groundspeed. From this intersection, parallel the timing lines up and over to determine the graph time. For this example the time equals 9.0 seconds.

4.10.2.6. Enter this value in the graph time block at the bottom of the form.

4.10.2.7. Extract the FTT from the AF Form 4018, block 29, and enter it in the FTT block at the bottom the form.

4.10.2.8. Subtract the FTT from the graph time to obtain a stop watch time.

4.10.2.9. Extract the Usable DZ Time from the AF Form 4018, block 34, and enter it in the appropriate block at the bottom of this form.

4.10.2.10. Add the Stop Watch Time to the Usable DZ time to obtain a running Red Light Time measured from your timing point.

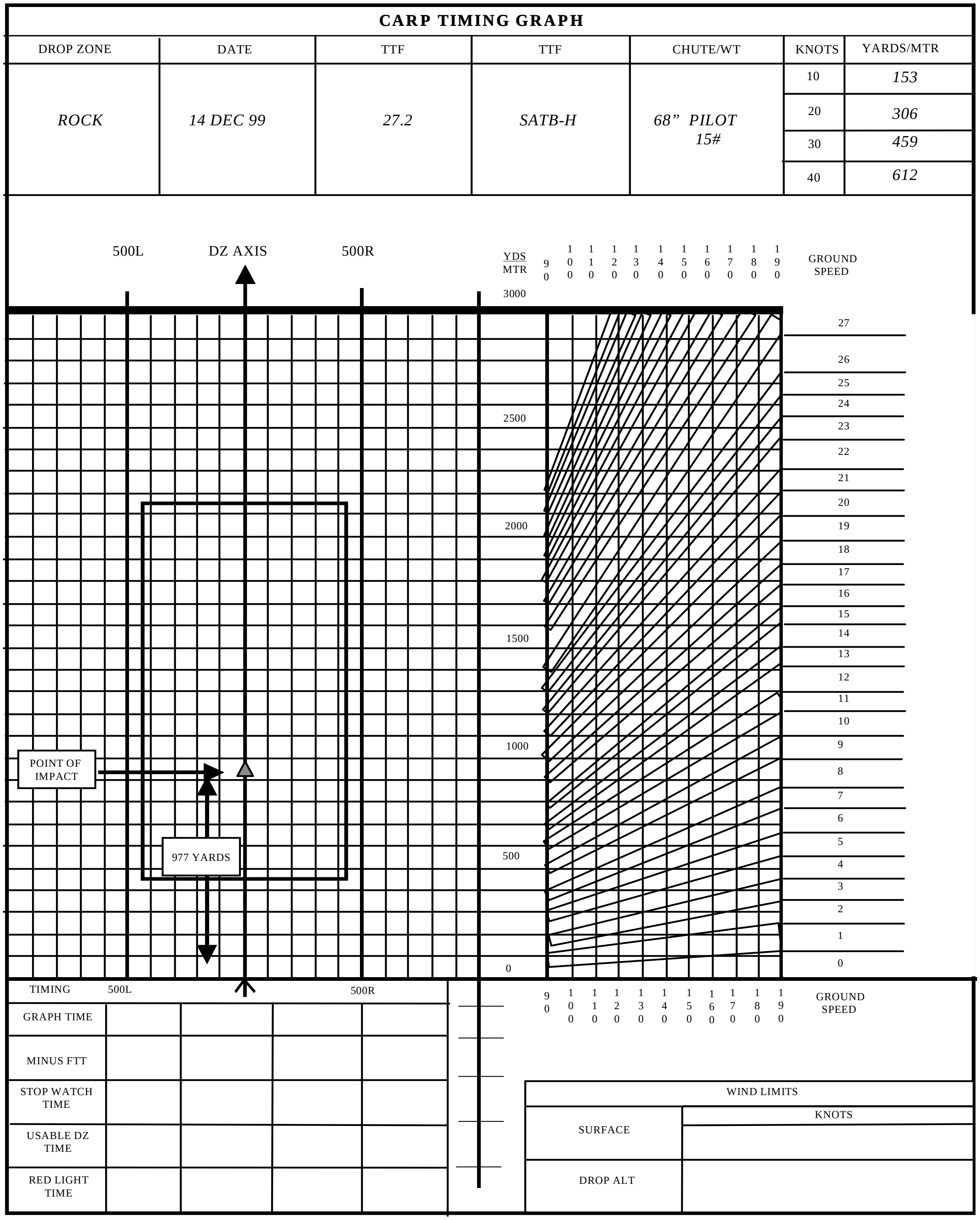
4.10.3. Modifications to this technique includes the following:

4.10.3.1. Delete the Usable DZ Time entry from the bottom of the chart and restart the timing for the designated red light time.

4.10.3.2. Plot not only the wind but also the FTD on the wind circle.

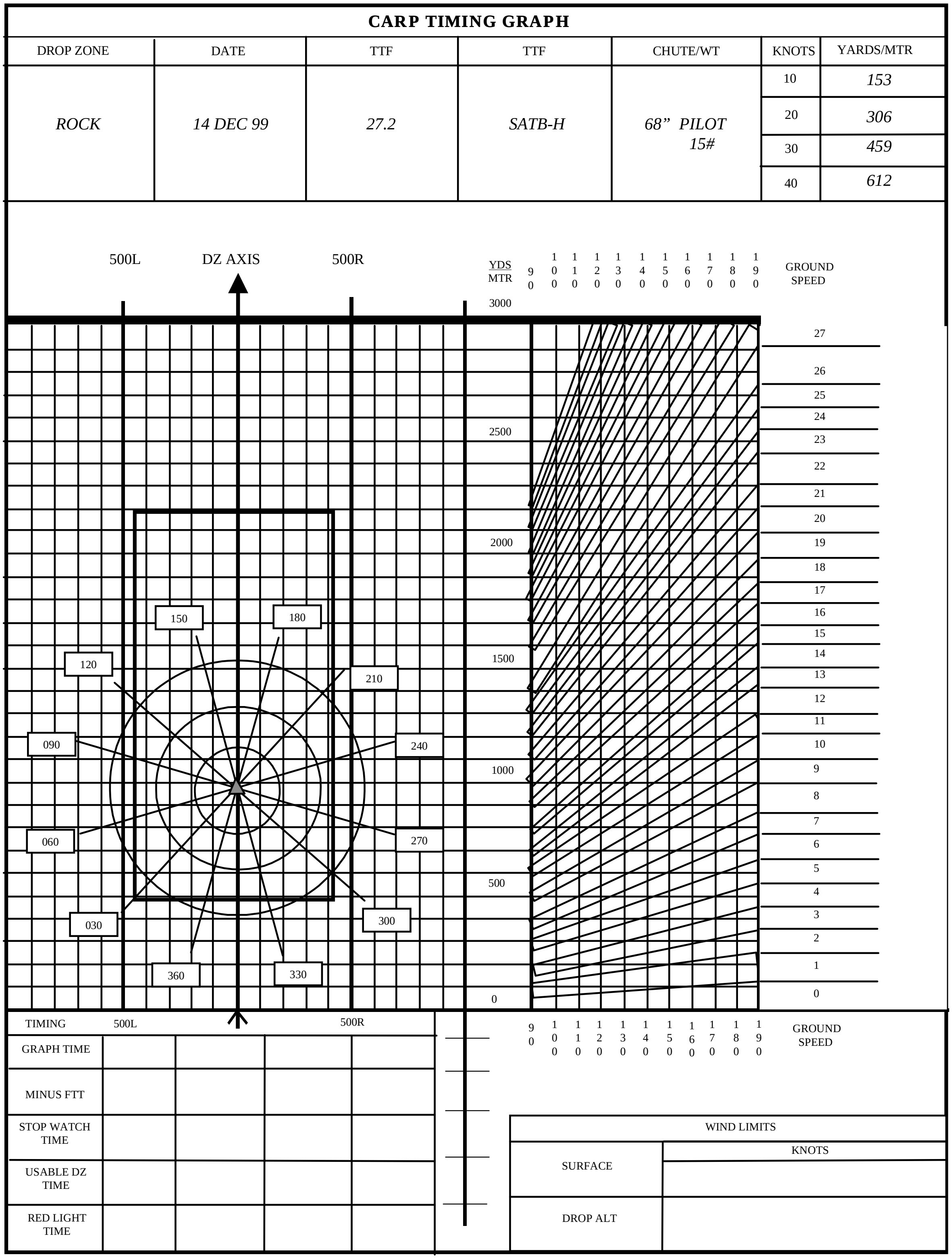
NOTE: When using this option, remember not to subtract the FTT. The graph time automatically equals the stop watch time.

Figure 4.10. Sight Angle Timing Graph Sample Part 1.



AF FORM 4018, MAY 98 (EF-V1) ***(REVERSE)***

Figure 4.11. Sight Angle Timing Graph Sample Part 2.



CARP TIMING GRAPH

DROP ZONE	DATE	TTF	TTF	CHUTE/WT	KNOTS	YARDS/MTR
ROCK	*14 DEC 99*	*27.2*	*SATB-H*	*68" PILOT 15#*	10	*153*
					20	*306*
					30	*459*
					40	*612*

TIMING	500L		500R	
GRAPH TIME				
MINUS FTT				
STOP WATCH TIME				
USABLE DZ TIME				
RED LIGHT TIME				

90 100 110 120 130 140 150 160 170 180 190 GROUND SPEED

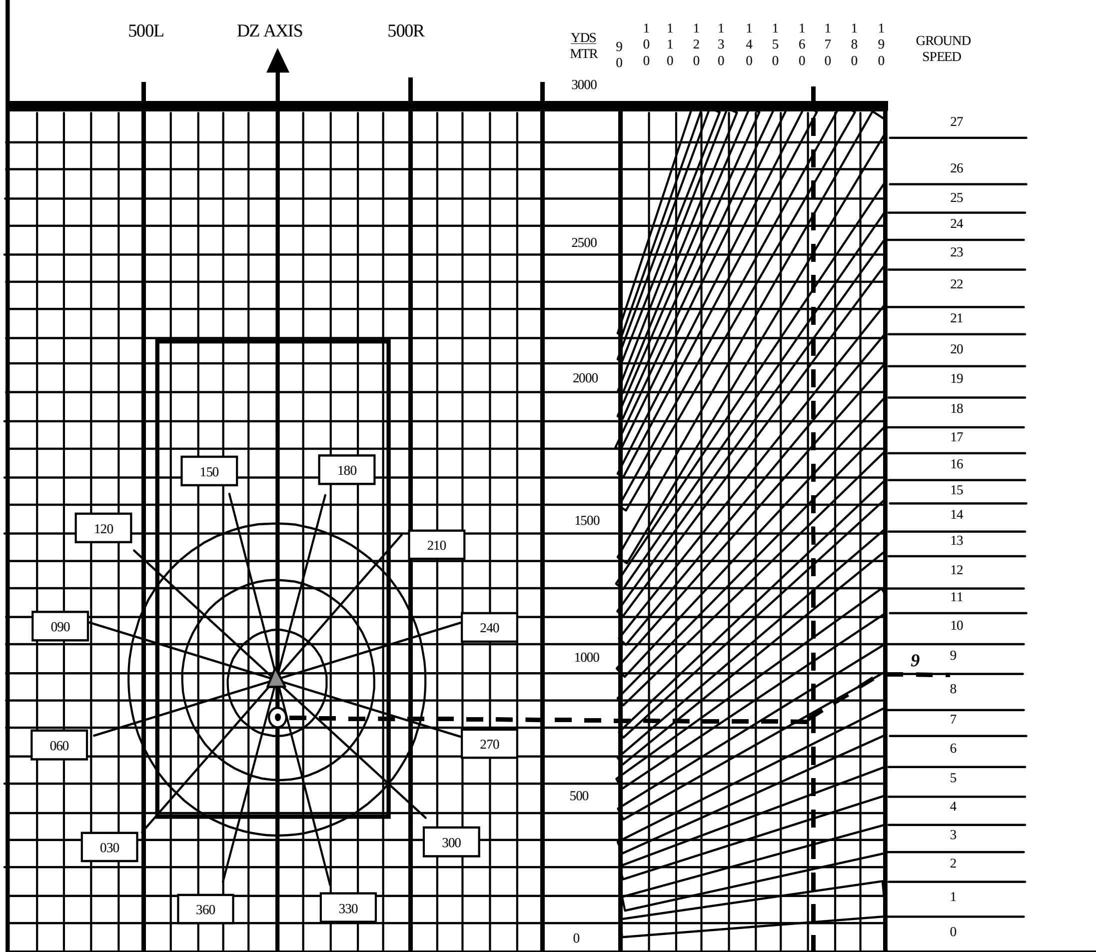
WIND LIMITS	
	KNOTS
SURFACE	
DROP ALT	

AF FORM 4018, MAY 98 (EF-V1) ***(REVERSE)***

Figure 4.12. Sight Angle Timing Graph Sample Part 3.

CARP TIMING GRAPH

DROP ZONE	DATE	TTF	TTF	CHUTE/WT	KNOTS	YARDS/MTR
ROCK	*14 DEC 99*	*27.2*	*SATB-H*	*68" PILOT 15#*	10	*153*
					20	*306*
					30	*459*
					40	*612*



TIMING	500L		500R	
GRAPH TIME	*9.0*			
MINUS FTT	*1.9*			
STOP WATCH TIME	*7.1*			
USABLE DZ TIME	*13.2*			
RED LIGHT TIME	*20.3*			

90 100 110 120 130 140 150 160 170 180 190 GROUND SPEED

WIND LIMITS	
	KNOTS
SURFACE	*25*
DROP ALT	*N/A*

AF FORM 4018, MAY 98 (EF-V1) ***(REVERSE)***

4.11. Inflight Forms Completion. The actual inflight data block is the same for both the AF Form 4013 and the AF Form 4018.

4.11.1. RCRD Data. Record the reported surface and mean effective winds, and the actual altitude winds at the time of the drop. Indicate the source of the winds if other than CCT/STS.

4.11.2. Drop Data. Should contain the data actually used to compute the updated CARP inflight.

4.11.2.1. Ballistic Wind: Wind used to compute the drift effect. Indicate whether measured (M) or interpolated (I).

4.11.2.2. Ground Speed: ground speed used to compute the FTD and usable DZ time inflight. Indicate whether computed by the aircrew member (C), displayed by INS, GPS, Doppler (D), or obtained from formation lead in a SKE formation (S).

4.11.2.3. Drift: Drift angle used to compute SKE offset. Indicate whether computed by the aircrew member (C), displayed by INS, GPS, Doppler (D), or obtained from formation lead in a SKE formation (S).

4.11.2.4. Green Light Time: Actual elapsed time, in seconds, from the timing point to the release point for a visual drop, or from lead's EXECUTE to the wingman's release point for a SKE drop. Use this block to indicate release method (A for AWADS, S for SKE, V for Visual) as well.

4.11.2.5. Red Light Time: Actual elapse time, in seconds, from release point to "red light" call.

4.12. Post Flight Forms Completion.

4.12.1. TOT: Record actual time over target (TOT) (for formation lead).

4.12.2. Formation Position: Record element and position within that element. Also indicate whether it was a SKE (S) or visual (V) formation. SS indicates single ship.

4.12.3. Raw Circular Error: Reported drop score. Enter "Sat" or "Unsat" for mass tac drops. For multiple passes, only the first score is recorded.

4.12.4. Corrected Circular Error: Raw circular error corrected in accordance with AF Form 4012, Airdrop Circular Error Computation. This is the score entered in the aircrew member's individual circular error record.

4.12.5. Turn in the AF Form 4013, 4015, 4017, and 4018 to the unit tactics office at the completion of the mission. The adjusted drop scores will be entered into the aircrew member circular error record.

Chapter 5

HIGH ALTITUDE RELEASE POINT SOLUTIONS

5.1. General . The high altitude release point (HARP) solution is a basic CARP solution with the addition of a third (high-velocity, free fall) vector. High altitude-low opening (HALO) drops are primarily personnel drops, although CDS may be dropped using a timer or barometrically actuated second-stage parachute release. The reverse side of the AF Form 4018, CARP Computation, or MAJCOM approved software product, will be used to solve and record HARP data.

Exception: C-17 MC will compute HARP

5.2. Responsibilities:

5.2.1. Compute a HARP for every high altitude airdrop. For multiple passes, recompute the HARP whenever drop altitude, actuation altitude, or significant wind changes occur.

5.2.2. An experienced parachutist can maneuver approximately 500 feet horizontally for each 1000 feet of free fall. In the event a parachutist cannot maneuver after exiting the aircraft (due to loss of visual ground references, injury, unconsciousness, or uncontrollable attitudes), or in the case of equipment delivery, an accurate HARP will ensure the load arrives in the vicinity of the intended point of impact. Additional modified HARP procedures are included in this chapter.

5.2.3. Due to the altitudes involved in this type of airdrops, visual methods of directing the aircraft to the HARP are normally less accurate than other electronic methods. These methods include INS/SCNS, GPS, GRADS, radar and radar beacon. All of these systems still require use of HARP computations, but they generally lead to better results. If the objective area or surrounding area is obscured, the airdrops when the ground is obscured there may be no way to steer toward the computed release point. Operational procedures and directives may require use of these systems for high altitude deliveries.

5.3. Equipment:

5.3.1. HALO personnel. Personnel parachutes normally used are the MC1, the MC3 Para-Commander, the MT1X, and the MT1S Ram-Air. The standard United States Army free fall parachute assembly (Type AP 28S-3) consists of a main pack and canopy, reserve pack and canopy, and harness. An F-1B automatic ripcord release is incorporated into the assembly to automatically open the parachute during preplanned jumping. This release allows automatic actuation down to an altitude of 4,500 feet. When lower actuation is desired, a modified F-1B, designated the FF-1, can be used. The FF-1 release can be set for altitudes down to 3,000 feet. The barometric device activates an adjustable 0-13 second timer which automatically pulls the ripcord. The FF-2 release is used with the MC3 parachute. Any of these automatic systems can be used; however, manual ripcord actuation is normal procedure.

5.3.2. HALO CDS:

5.3.2.1. Stabilized. Containers are rigged with a small stabilization parachute which, when inflated, is used to achieve a high velocity rate of fall, 200+ feet per second, to a selected altitude where a barometric sensing device actuates a timing device and cutter to deploy a larger cargo parachute.

5.3.2.2. Reefed or Confined Ballistic System (CBS). Containers are rigged with a 22 or 28 foot ring slot, G-12D or similar type cargo parachute which is reefed down to a specific diameter and equipped with one or more dereefing devices. The load descends with the chute in a reefed condition at approximately 130 feet per second until a predetermined burn time has expired and actuation of the cutter system occurs. This system cuts the reefing lines, allowing the chute to inflate fully and slow the load descent to approximately 70 feet per second for the 22 or 28 foot ring slot and 26 feet per second for the 12 foot ring slot.

5.3.3. High Velocity CDS. These loads are rigged with a ring slot parachute and descend at approximately 65-100 feet per second. Loads normally consist of indestructible type supplies which can withstand the high velocity impact. Normally, staging devices are not utilized.

5.3.4. High Altitude Airdrop Resupply System (HAARS). The HAARS delivers containers from an aircraft flying at altitudes up to 25,000 feet. The containers can be dropped singly or in multiples to two. Up to 16 containers can be dropped from the C-130 aircraft and up to 40 from the C-141 . When the container leaves the aircraft, a modified 68 inch pilot chute opens and keeps the load upright while it falls at a terminal velocity of 250 feet per second. when the right altitude is reached, the sensor cuts a sheer web. This allows a cargo parachute to open and the load to land at an acceptable rate of speed.

5.4. Basic Assumptions. The deployment altitude obtained from the jumpmaster is considered to be the altitude where full parachute deployment occurs and a constant rate of descent is established. Actuation altitude (for manual ripcord pull) is normally considered to be 500 feet above the deployment altitude. The aircrew member should confirm which altitude, deployment or actuation, corresponds to the altitude figure received. When the FF-1, FB-1, or similar device is used for HALO CDS, actuation altitude is the altitude at which the ripcord/cutter starts deployment of the second stage parachute.

5.5. Altitudes:

5.5.1. Pressure altitude or indicated true altitude is used as the aircraft drop altitude reference. The drop altitude and actuation altitude must be converted to absolute altitudes for HARP computations. Indicated altitude is the altitude to be flown with an externally supplied (surface) DZ altimeter setting. Pressure altitude is the altitude to be flown with an altimeter setting of 29.92.

5.5.2. The HALO parachutist can use any of three altimeter types to determine desired parachute actuation/deployment altitude:

5.5.2.1. An adjustable pressure altimeter with a Kollsman window. This enables parachutists to manually activate their own parachute, based on indicated true altitude or indicated pressure altitude.

5.5.2.2. An adjustable pressure altimeter without Kollsman window. The parachutist will usually adjust this type of altimeter so that it displays altitudes with respect to point of impact elevation. This enables parachutist to normally activate their own parachute, based on indicated altitude above ground level. This is the most common method used by US Army personnel.

5.5.2.3. A non-adjustable pressure altimeter (29.92 in Hg/1013.2 Mb). This enables parachutists to manually activate their own parachute, based on indicated pressure altitude.

5.6. Wind Determination:

5.6.1. There are two winds used in HARP computations:

5.6.1.1. Ballistic Wind. The vectorial average of the winds from drop altitude to actuation altitude or ground level when single stage drops are made.

5.6.1.2. Deployed Wind. The vectorial average of the winds from actuation altitude to the ground.

5.6.2. Normally, the weather forecaster is not trained to calculate the vectorial average of winds; therefore, the aircrew member should request winds at the required altitudes and compute the average. Ballistic winds are computed using winds for every 2,000 feet from drop altitude down; deployed winds are computed using winds for ever 1,000 feet or less from actuation altitude down to the surface.

5.7. Completion of the AF Form 4015, High Altitude Release Point Computations:

5.7.1. Item 1. Drop Indicated True Altitude - Altitude, in feet above mean sea level, to be flown with the DZ altimeter setting in the barometric scale of the pressure altimeter.

5.7.2. Item 2. Pressure Altitude Variation - Pressure difference, in feet, between mean sea level and the standard datum plane, The pressure altitude variation (PAV) is computed using the DZ altimeter setting. If the DZ altimeter setting is greater than 29.92, the PAV is subtracted from the indicated true altitude to obtain pressure altitude. The PAV is added when the altimeter setting is less than 29.92 (compute using formula A).

5.7.3. Item 3. Drop Pressure Altitude - Drop altitude, in feet above the standard datum plane. The altitude to be flown with 29.92 set in the pressure altimeter. Item 1 plus item 2.

5.7.4. Item 4. “D” Value - The difference, in feet, between the true altitude of the aircraft and the pressure altitude of the aircraft. The “D” is obtained from the weather forecaster or can be measured en route by radar altitude plus terrain elevation minus pressure altitude.

5.7.5. Item 5. Drop True Altitude - Altitude, in feet above mean sea level. Item 3 plus item 4. To verify forecast “D: values or if a “D” value cannot be obtained, drop true altitude may be approximated by using the ALTITUDE COMPUTATIONS window of the MB-4 computer and the formula:

$$\frac{\text{Drop Altitude Temp}}{\text{Drop Pressure Alt}} = \frac{\text{(Drop True Altitude)}}{\text{Indicated True Altitude}}$$

5.7.6. Item 6. Point of Impact Elevation - MSL elevation, in feet, of the PI.

5.7.7. Item 7. Drop Altitude - Absolute altitude, in feet, above the PI (Item 5 minus item 6)

5.7.8. Item 8. Drop Altitude Temperature - Temperature, in degrees Celsius, at the drop altitude.

5.7.9. Item 9. Point of Impact Elevation - For computing PI pressure altitude. Same as item 6.

5.7.10. Item 10. Pressure Altitude Variation - same as item 2.

5.7.11. Item 11. Point of Impact Pressure Altitude - Item 9 plus item 10.

5.7.12. Item 12. Point of Impact Temperature - Temperature, in degrees Celsius, at the PI.

NOTE: Items 13 through 32 need not be accomplished for single stage airdrops.

5.7.13. Item 13. Actuation Indicated Altitude - Uncorrected absolute altitude, in feet, above the PI. Start the computations here when a barometric altimeter is used which is set to read zero (0) feet at the intended landing location.

5.7.14. Item 14. Point of Impact Elevation - same as item 6.

5.7.15. Item 15. Actuation Indicated True Altitude - Uncorrected actuation altitude, in feet above mean sea level. Item 13 plus item 14. Start computations here when an altimeter with the local altimeter setting is used for a parachute actuation.

5.7.16. Item 16. Pressure Altitude Variation - Same as item 2.

5.7.17. Item 17. Actuation Altitude Temperature - Temperature in degrees Celsius at actuation altitude.

5.7.18. Item 18. Actuation Pressure Altitude - Actuation altitude, in feet above the standard datum plane. Item 15 plus item 16. Start computations here when the standard atmosphere setting of 29.92 in Hg or 1013 Mb is set in the altimeter used for parachute actuation. Compute actuation indicated true altitude (item 15) before going on.

5.7.19. Item 19. Actuation True Altitude - Altitude in feet, above ground level where actuation occurs. compute on the DR computer using the ALTITUDE COMPUTATIONS window and the formula:

$$\frac{\text{Act Alt Temp (item 17)}}{\text{Act Press Alt (item 18)}} = \frac{\text{(Act True Alt)}}{\text{Act Ind Alt (item 13)}}$$

5.7.20. Item 20. Point of Impact Elevation - Same as item 6.

5.7.21. Item 21. Actuation Altitude - Corrected actuation altitude, in feet above mean sea level. Item 19 minus item 20.

5.7.22. Item 22. Deceleration Distance - Vertical distance, in feet, the parachutist/load falls from staging system actuation until full deployment of the recovery parachute(s). Obtain from parachute ballistic data.

NOTE: The FF-1, FB-1, and similar timers can be set to utilize a 0-13 second delay upon reaching the actuation altitude. It is necessary to convert the selected delay to altitude lost during the delay period. Add this distance to the deceleration distance extracted from the ballistic data. Use the formula:

$$\frac{\text{High Velocity Adj Rate of Fall}}{\text{(Delay Distance)}} = \frac{1.0}{\text{Delay Time}}$$

5.7.23. Item 23. Deployment Altitude - Item 21 minus item 22.

5.7.24. Item 24. Deployed Midpressure Altitude - Average altitude used to compute the deployed adjusted rate of fall. This altitude is the actuation pressure altitude (item 18) minus deceleration distance (item 22) plus the PI pressure altitude (item 11) divided by two.

5.7.25. Item 25. Deployed Temperature - Temperature, in degrees Celsius, used to compute deployed adjusted rate of fall. Compute by averaging surface temperature and deployment altitude temperature.

5.7.26. Item 26. Deployed Rate of Fall - Sea level, standard day rate of fall, in feet per second. Obtained from the parachute ballistic data.

5.7.27. Item 27. Deployed Adjusted Rate of Fall - Deployed rate of fall, in feet per second, corrected for air density. Compute on the MB-4 computer using the Density Altitude Computations window and the formula:

$$\frac{\text{Deployed Temp (item 25)}}{\text{Deployed Mid-Pressure Altitude (item 24)}} = \frac{\text{(Deployed adjusted rate of fall)}}{\text{Deployed Rate of Fall (item 26)}}$$

5.7.28. Item 28. Deployed Time of Fall - Elapsed time, in seconds, from deployment altitude until the parachutist/load reaches ground level. Compute using the formula:

$$\frac{\text{Deployed Adjusted Rate of Fall (item 27)}}{\text{Deployment Altitude (item 23)}} = \frac{1}{\text{(Deployed Time of Fall)}}$$

5.7.29. Item 29. Deceleration Time - Elapsed time, in seconds, form actuation of the staging system to deployment of the recovery parachute(s). Obtain form the parachute ballistic data. When using a time delay with the FF-1, FB-1 or similar device, add the number of seconds delay.

5.7.30. Item 30. Total Time of Fall - Total elapsed time, in seconds, from actuation of the staging system to ground impact. Item 28 plus item 29.

5.7.31. Item 31. Deployed Wind see paragraph **5.6.1.2.**

5.7.32. Item 32. Deployed Drift Effect - Total drift, in yards, incurred by the parachutist/load during the descent from actuation altitude to the ground.

$$\frac{\text{Total Time of Fall (item 30)}}{\text{1.78 (1.94 to convert meters)}} = \frac{\text{(Deployed Drift Effect)}}{\text{Deployed Wind Speed (item 31)}}$$

5.7.33. Item 33. Drop Altitude - Same as item 7.

5.7.34. Item 34. Vertical Distance - Distance, in feet, the load/parachutist descends after exiting the aircraft until reaching a stabilized condition. Obtain from the parachute ballistic data.

5.7.35. Item 35. Stabilization Altitude - Item 33 minus item 34.

5.7.36. Item 36. Actuation Altitude - Use actuation altitude (item 21) for two-stage airdrop. Use zero (0) when dropping high velocity loads or loads not using second stage recovery parachutes.

5.7.37. Item 37. High Velocity Fall Distance - Distance, in feet, the parachutist/load descends form stabilization to actuation of the second stage recovery system or until reaching ground level. Item 35 minus time 36.

5.7.38. Item 38. High Velocity Mid-Pressure Altitude (HVMPA) - The average pressure altitude used to compute the adjusted rate of fall. Compute using the following formula:

HVMPA = <u>Item 3-Item 34 + Item 18 (Item 11 for single stage)</u> - all divided by 2

5.7.39. Item 39. High Velocity Temperature - Temperature, in degrees Celsius, used to compute adjusted rate of fall. Compute by averaging drop altitude and actuation/surface altitude temperatures.

5.7.40. Item 40. High Velocity Rate of Fall - Sea level standard day rate of fall, in feet per second, obtained from the parachute ballistic data.

5.7.41. Item 41. High Velocity Adjusted Rate of Fall - High velocity rate of fall, in feet per second, corrected for air density. Compute on the MB-4 computer using the DENSITY ALTITUDE COMPUTATION window and the formula:

$$\frac{\text{High Velocity Temperature (item 39)}}{\text{HVMPA (item 38)}} = \frac{\text{(High Velocity Adj Rate of Fall)}}{\text{High Velocity Rate of Fall (item 40)}}$$

5.7.42. Item 42. High Velocity Time of Fall - Elapsed time, in seconds, form stabilization altitude until actuation altitude or ground impact. Compute using the formula:

$$\frac{\text{High Velocity Adj Rate of Fall (item 41)}}{\text{High Velocity Fall Distance (item 37)}} = \frac{1.0}{\text{(High Velocity Time of Fall)}}$$

5.7.43. Item 43. Time of Fall Constant - A false time constant in seconds used to determine drift effect during the time the parachutist/load falls after exiting the aircraft until reaching the stabilization altitude. Obtain from the parachute ballistic data.

5.7.44. Item 44. High Velocity Total Time of Fall - Time (used to determine drift effect, Item 42 plus item 43), in seconds, from parachutist/load exiting the aircraft until reaching actuation altitude or ground level.

5.7.45. Item 45. Ballistic wind - see 5.6.1.1.

5.7.46. Item 46. High Velocity Drift Effect - Total drift in yards incurred by the parachutist/load while descending from drop altitude to actuation altitude or ground level. compute using the formula:

$$\frac{\text{High Velocity Total Time of Fall (item 44)}}{\text{1.78 (1.94 to convert meters)}} = \frac{\text{(High Velocity Drift Effect)}}{\text{Ballistic Wind Speed (item 45)}}$$

5.7.47. Item 47. Indicated/Calibrated/Equivalent Airspeed - Drop IAS as specified in operational regulations; the IAS corrected for pitot-static error, aircraft altitude and instrument error. CAS is IAS corrected for compressibility. EAS is determined from aircraft performance data.

5.7.48. Item 48. True Airspeed - Airspeed determined on the MB-4 computer knowing EAS, drop pressure altitude, and drop altitude temperature.

5.7.49. Item 49. Drop Altitude Wind - Forecast or inflight wind which dictates/affects the heading of the aircraft at release, forward travel distance, and the timing problem (may substitute true winds).

5.7.50. Item 50. Course - Run-in course. Obtain from planning sheet or DZ.

5.7.51. Item 51. Drift Correction - Calculated using drop altitude wind, TAS, and course.

5.7.52. Item 52. Heading - Heading to be flown at time of load release.

5.7.53. Item 53. Goundspeed - Preflight or actual groundspeed calculated.

5.7.54. Item 54. Exit Time - Elapsed time, in seconds, from "green light" until the parachutist/load exits the aircraft. Obtain from the parachute ballistic data.

5.7.55. Item 55. Deceleration Quotient - A time, in seconds, added to exit time to determine the forward travel time. Obtain from the parachute ballistic data.

5.7.56. Item 56. Forward Travel Time - Item 54 plus item 55.

5.7.57. Item 57. Forward Travel Distance - Ground distance in yards along track the parachutist/load travels after "green light " until reaching a determined percentage of terminal vertical or horizontal velocity. Compute using the formula:

$$\frac{\text{Groundspeed (item 53)}}{\text{1.78 (1.94 to convert to meters)}} = \frac{\text{(Forward Travel Distance)}}{\text{Forward Travel Time (item 56)}}$$

5.7.58. Item 58. Stop Watch Distance - Ground distance in yards measured on the DZ depiction from a ground reference point, or from an electronic aid, down track to the HARP.

5.7.59. Item 59. Stop Watch Time - Time, in seconds, that will elapse as the aircraft traverses the stop watch distance. Compute using the formula:

$$\frac{\text{Groundspeed (item 53)}}{\text{1.78 (1.94 to convert form meters)}} = \frac{\text{Stop Watch Distance (item 58)}}{\text{(Stop Watch Time)}}$$

5.7.60. Item 60. Usable Drop Zone Length - distance in yards from the PI to the end of the DZ. During CDS multiple container airdrops, 50 yards will be subtracted for each additional lateral row of containers.

5.7.61. Item 61. Usable Drop Zone Time - Usable DZ length convert to time, in seconds, minus a one-second safety factor. Compute using the formula:

$$\frac{\text{Groundspeed (item 53)}}{\text{1.78 (1.94 to convert form meters)}} = \frac{\text{Usable DZ length (item 60}}{\text{(Usable DZ Time)}}$$

5.7.62. Item 62. Red Light Time - Elapsed time from the timing point after which airdrops cannot be initiated safely. Item 59 plus item 61.

Figure 5.1. AF Form 4015.

STANDARD CARP/HARP SOLUTION

DATE (Day, Month, Year): 1 Aug 02

NAVIGATOR'S NAME (Print)	CALL SIGN	ORGANIZATION	CHUTE (Type & Number)	LOAD WEIGHT	DROP ZONE	SIGNATURE
HOFFER, JEFF	LIFTER 99	9 SOS	MT1XX	225	Pegasus	Jeff Hoffer

1	DROP INDICATED TRUE ALTITUDE		16500			32	DEPLOYED DRIFT EFFECT	F	2485		
2	PRESSURE ALTITUDE VARIATION	+ A	0			33	DROP ALTITUDE		16310		
3	DROP PRESSURE ALTITUDE		16500			34	VERTICAL DISTANCE	-	180		
4	"D" VALUE	+	200			35	STABILIZATION ALTITUDE		16130		
5	DROP TRUE ALTITUDE		16700			36	ACT ALTITUDE/ PI ELEVATION	-	3480		
6	POINT OF IMPACT ELEVATION	-	390			37	HIGH VELOCITY FALL DISTANCE		12650		
7	DROP ALTITUDE		16310			38	HIGH VELOCITY MID PRESSURE ALTITUDE		10105		
8	DROP ALTITUDE TEMPERATURE		-16			39	HIGH VELOCITY TEMPERATURE		-3		
9	POINT OF IMPACT ELEVATION		390			40	HIGH VELOCITY RATE OF FALL		156.6		
10	PRESSURE ALTITUDE VARIATION	+ A	0			41	HIGH VELOCITY ADJ RATE OF FALL	C	156.7		
11	POINT OF IMPACT PRESSURE ALTITUDE		390			42	HIGH VELOCITY TIME OF FALL	E	80.1		
12	POINT OF IMPACT TEMPERATURE		+15			43	TIME OF FALL CONSTANT	+	5.4		
13	ACTUATION INDICATED ALTITUDE		3500			44	HIGH VELOCITY TOTAL TIME OF FALL		85.5		
14	POINT OF IMPACT ELEVATION	+	390			45	BALLISTIC WIND		155/60		
15	ACTUATION INDICATED TRUE ALTITUDE		3890			46	HIGH VELOCITY DRIFT EFFECT	F	2880		
16	PRESSURE ALTITUDE VARIATION		0			47	IAS/CAS/EAS		130/132		
17	ACTUATION ALTITUDE TEMPERATURE		+7			48	TRUE AIRSPEED		171		
18	ACTUATION PRESSURE ALTITUDE		3890			49	DROP ALTITUDE WIND		170/75		
19	ACTUATION TRUE ALTITUDE	B	3870			50	TRUE/MAG COURSE		072		
20	POINT OF IMPACT ELEVATION	-	390			51	DRIFT CORRECTION		+21		
21	ACTUATION ALTITUDE		3480			52	TRUE/MAG HEADINGS		093		
22	DECELERATION DISTANCE	-	380			53	GROUND SPEED		168		
23	DEPLOYMENT ALTITUDE		3100			54	EXIT TIME		2.3		
24	DEPLOYMENT MID PRESSURE ALTITUDE		1950			55	DECELERATION QOUTIENT	+	1.5		
25	DEPLOYED TEMPERATURE		+9			56	FORWARD TRAVEL TIME		3.8		
26	DEPLOYED RATE OF FALL		17.4			57	FORWARD TRAVEL DISTANCE	G	339		
27	DEPLOYED ADJUSTED RATE OF FALL	C	17.8			58	STOP WATCH DISTANCE		-		
28	DEPLOYED TIME OF FALL	E	174.0			59	STOP WATCH TIME		-		
29	DECELERATION TIME	+	3.4			60	USABLE DZ LENGTH		800		
30	TOTAL TIME OF FALL		177.4			61	USABLE DZ TIME (Minus one second)		8.5		
31	DEPLOYED WIND		120/25			62	RED LIGHT TIME (59 plus 61)		--		

A: $\frac{29.92}{+} \quad \frac{29.92}{29.92 \; -0}$

B: $\frac{\text{Temperature}}{\text{Pressure Altitude}} = \frac{\text{(True Altitude)}}{\text{Indicated True Altitude}}$

C: $\frac{\text{Temperature}}{\text{Mid Pressure Altitude}} = \frac{\text{(Adj Rate of Fall)}}{\text{Rate of Fall}}$

TOT	CE
1640.3	PI

E: $\frac{\text{Adj Rate of Fall}}{\text{Alt/Fall Distance}} = \frac{1.0}{\text{(Time of Fall)}}$

F: $\frac{\text{Total Time of Fall}}{1.78\ (1.94\ \text{Mtr})} = \frac{\text{(Drift Effect)}}{\text{Wind speed}}$

G: $\frac{\text{Ground Speed}}{1.78\ (1.94\ \text{Mtr})} = \frac{\text{(Distance)}}{\text{(Time)}}$

AF Form 4015 REPLACES AMC FORM 512, JUN 92

5.8. Personnel HARP Computations. To compute a personnel HARP, only the following blocks of the AF For 4015 need be filled in 13-15, 24-28, 31-33, 36-41, 43-57, 60-61.

5.9. HARP Computation Using the Formula D=KAV:

5.9.1. The formula D=KAV is an accurate approximation of drift effect where:
D = drift effect in meters
K = ballistic wind constant (free fall= 3
deployed = 25)
A = altitude in thousands of feet
V = average wind velocity

The D=KAV method can be used to compute personnel HALO release points when MC-1, MC-3 or similar type, parachutes are used. When this computation method is used, the following documentation is required on the AF Form 4015.

Indicated Drop Altitude (true or pressure)	item 1 or 3
Drop Altitude (AGL)	item 7
Actuation Altitude (AGL)	item 21
Deployed Wind	item 31
Deployed Wind Effect	item 32
Ballistic Wind	item 45
High Velocity Drift Effect	item 46
Normal CARP Data	item 47-62

5.9.2. The HARP computation is divided into three components:

5.9.2.1. Deployed Drift Effect (DDE) is determined by computing the average wind velocity and direction from activation altitude to the ground and using the following formula:

DDE = 25 x Altitude in thousands of feet x average wind velocity

Example:

4000 ft winds	190/15
3000 ft winds	220/14
2000 ft winds	205/11
1000 ft winds	220/ 9
TOTALS	835/49

Average wind direction 835/4 = 209
Average wind velocity 211/4 = 12 kts
DDE = 25 x 4 x 12 = 1200 meters

5.9.2.2. High Velocity Drift Effect (HVDE) is determined by computing the average wind velocity and direction from exit to opening altitude and using the following formula:

HVDE = 3 x Altitude in thousands of feet x average wind velocity

Example:

20,000 ft winds	160/85
18,000 ft winds	160/75
16,000 ft winds	165/75
14,000 ft winds	165/65
12,000 ft winds	155/50
10,000 ft winds	150/45
8,000 ft winds	185/20
6,000 ft winds	190/20
4,000 ft winds	190/15
TOTALS	1520/450

Average wind direction 1520/9 = 169

Average wind velocity 173/9 = 50 kts

HVDE = 3 x 16 x 50 = 2400 meters

5.9.2.3. Forward Travel Distance - compute using blocks 47 through 57 on AF Form 4015.

5.10. Plotting Instructions:

5.10.1. Select a properly scaled chart (1:50,000 or 1:24,000 scale is recommended).

5.10.2. Plot the Deployed Drift Effect (DDE) upwind from the PI. This is the deployed drift effect plot.

5.10.3. Plot the High Velocity Drift Effect (HVDE) upwind from the deployed drift effect plot. This is the HVDE plot.

5.10.4. Plot the FTD from the HVDE plot down track the reciprocal run in course. This is the HARP.

5.10.5. Modified HARP solutions and plots are included in this instruction.

5.11. Completion of the AF Form 4017, Modified HARP Solution.

5.11.1. Items 1 through 4 are the same as items 1 through 4 above in paragraph **5.7.**

5.11.2. Item 5. Drop True Altitude - The altitude, in feet, above mean sea level. The altitude to be flown when the altimeter setting is derived by in-flight altimeter calibration. Item 3 plus Item 4. To verify forecast "D" value, or when one cannot be obtained, drop true altitude may be approximated by using the ALTITUDE COMPUTATIONS window of the DR computer and the formula:

$$\frac{\text{Drop Altitude Temp}}{\text{Drop Pressure Alt}} = \frac{\text{(Drop True Altitude)}}{\text{Drop Ind True Altitude}}$$

5.11.3. Item 6. Point of Impact Elevation - The elevation, in feet, of the PI.

5.11.4. Item 7. Drop Absolute Altitude - The absolute altitude, in feet, above the PI (AGL). (Item 5 minus Item 6).

5.11.5. Item 8. Safety Factor (HAHO)/Actuation Altitude(HALO) - For HAHO operations, enter desired team safety factor, in feet, (opening delay + approach); for HALO operations, enter the altitude, in feet, above the PI where the parachutist manually pulls the ripcord.

5.11.6. Item 9. Drive Altitude (HAHO)/High Velocity Fall Distance (HALO) - For HAHO operations the altitude, in feet, the parachutist falls after exiting the aircraft minus his safety factor, for HALO operations the altitude, in feet, the parachutist falls after exiting the aircraft minus actuation altitude. (Item 7 minus Item 8).

5.11.7. Item 10. "K" Factor - The ballistic constant used to calculate drift distance or drive distance.

5.11.8. Item 11. Ballistic Wind - the resultant magnetic wind affecting the parachutist during descent from drop altitude to ground level or actuation altitude.

5.11.9. Item 12. Drive Distance (HAHO) or High Velocity Drift Effect (HALO) - The total drive or drift, in NM or meters, incurred by the parachutist during descent from drop altitude to the ground or actuation altitude using formula B.

WARNING: For HAHO operations, this puts the parachutists at their maximum theoretical drive distance. In the interest of safety, a percentage (e.g., 80%) of the total computed drive distance may be used. When a percentage safety factor is used, split item 12 indicating; the total drive distance, percentage of total drive distance used, and its corresponding value.

5.11.10. Item 13. Actuation Altitude - The altitude, in feet, above ground level where the parachutist deploys his recovery parachute.

5.11.11. Item 14. Approach Factor (Ram-Air)(HALO) - The altitude, in feet, above the ground the parachutist desires to be overhead the DZ in order to maneuver for approach. No entry required for MC-1/3 HALO operations.

5.11.12. Item 15. Deployed Drift Distance (HALO) - The altitude, in feet, the parachutist falls from actuation of recovery parachute and ground level (Item 13 minus Item 14).

5.11.13. Item 16. Deployed Ballistic Wind - The magnetic wind affecting the parachutist from actuation altitude until ground level.

5.11.14. Item 17. Deployed "K" Factor - The constant used to calculate drift or drive distance during the deployed phase of flight.

5.11.15. Item 18. Deployed Drift Effect (HALO) - The drift, in meters, incurred by the parachutist during descent from actuation altitude to the ground.

WARNING: This puts the parachutists at their maximum theoretical drive distance. In the interest of safety, a percentage (e.g., 80%) of the total computed drive distance may be used. When a percentage safety factor is used, split item 18, the total drive distance, percentage of total drive distance used, and its corresponding value.

5.11.16. Item 19. Drop Altitude Temperature - The temperature, in degrees Celsius, at the drop true altitude.

5.11.17. Item 20. IAS/CAS/EAS/TAS - The drop indicated airspeed, equivalent airspeed, calibrated airspeed, or true airspeed as specified in operational regulations; the IAS corrected for pitot-static error, aircraft attitude and instrument error; CAS corrected for compressibility. EAS is determined from aircraft performance data; TAS determined on the DR computer.

5.11.18. Item 21. Drop Altitude Wind - The forecast magnetic wind at drop altitude.

5.11.19. Item 22. Course - The course from IP to the release point. Obtain from DZ data or depiction.

5.11.20. Item 23. Drift Correction - Compute on the DR computer using drop altitude wind, TAS, and magnetic course.

5.11.21. Item 24. Heading - The heading to be flown at parachutist release. Item 22 plus Item 23.

5.11.22. Item 25. Groundspeed - The preflight groundspeed obtained from the DR computer using magnetic course and TAS.

5.11.23. Item 26. Forward Travel Time or Forward Travel Distance - The time or distance the parachutist travels along IP-DZ track after green light until reaching terminal velocity. Compute FTD using a FTT of 4.6 seconds, groundspeed and formula C.

5.11.24. Item 27. Timing Point Distance - The ground distance in yards (meters) measured on the DZ depiction from a ground reference point or from an electronic aid, downtrack to the HARP.

5.11.25. Item 28. Timing Point Time - The time in seconds that will elapse as the aircraft traverses the timing point distance. Compute using formula C.

5.11.26. Item 29. Usable DZ Length (UDZL) - The distance in yards from the PI to the end of the DZ.

5.11.27. Item 30. Usable DZ Time (UDZT) - The UDZL converted to time, in seconds. Compute using formula C.

5.11.28. Item 31. Red Light Time - The elapsed time from the timing point after which airdrops cannot be made safely. Item 28 plus Item 30.

5.11.29. Using SCNS for HALO/HAHO Airdrops. Programming the SCNS for a HARP solution requires several additional items which are not on the AF Form 4017. SCNS requires Deployed Rate of Fall, High Velocity Rate of Fall, Deceleration Time, Deceleration Distance, Vertical Distance, Time of Fall Constant, and Forward Travel Time. All other items SCNS requires to compute its HARP solution can be found on the AF Form 4017.

Figure 5.2. HARP Diagram.

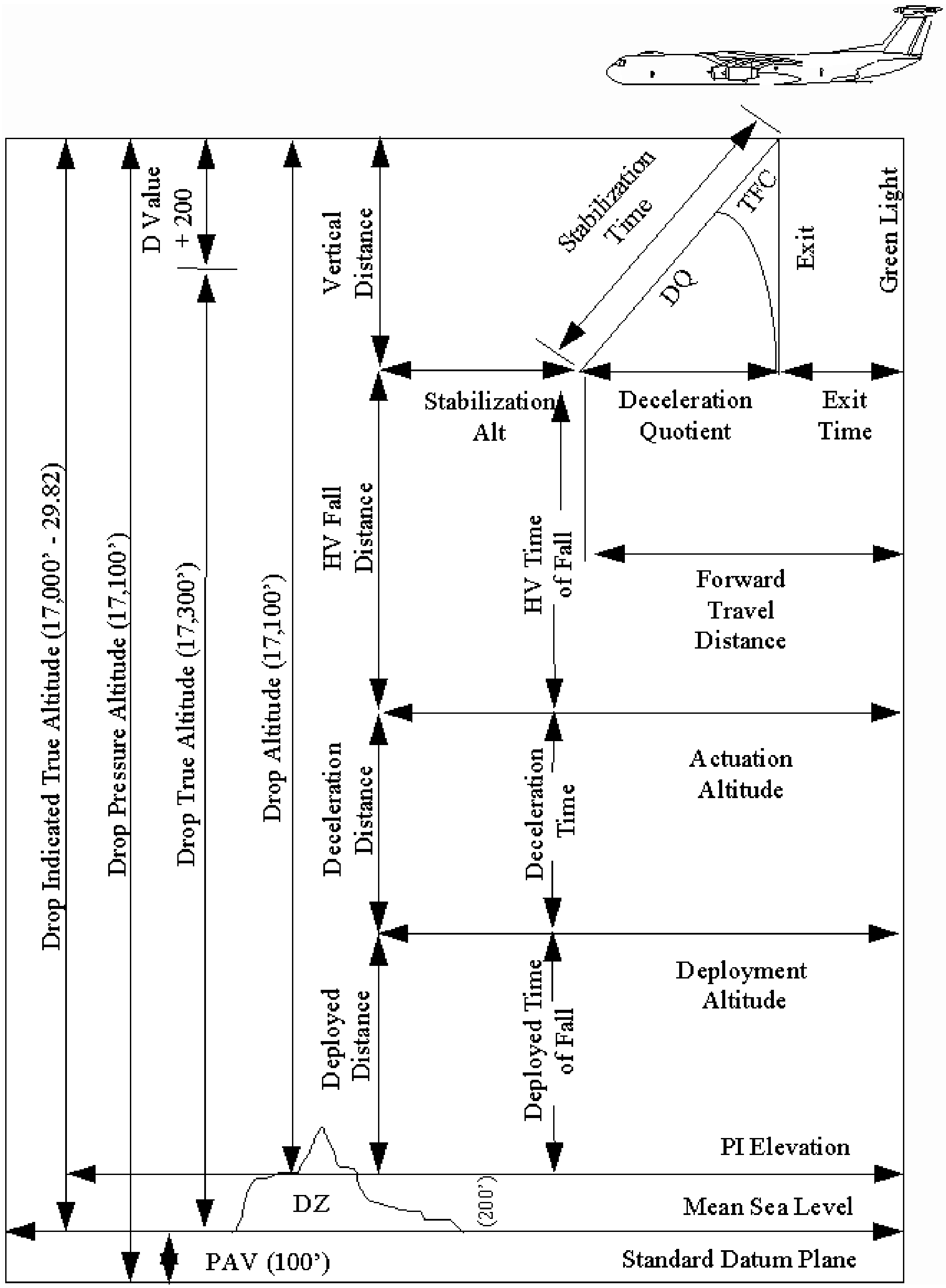


Figure 5.3. AF Form 4017 Sample.

MODIFIED H IGH ALTITUDE RELEASE POINT COMPUTATION

DATE (Day, Month, Year): 1 Aug 01

NAVIGATOR'S NAME (Print)	CALL SIGN	ORGANIZATION	NAVIGATOR'S SIGNATURE
GLAZE, JOHN	KING 44	9 SOS	John Glaze

1	DROP INDICATED TRUE ALTITUDE (DZ ALTIMETER)		19,880		
2	PRESSURE ALTITUDE VARIATION	+ A	-380		
3	DROP PRESSURE ALTITUDE (29.92 SET)		19,500		
4	"D" VALUE	+	+750		
5	DROP TRUE ALTITUDE (MSL)		20,250		
6	POINT OF IMPACT ELEVATION	-	250		
7	DROP ABSOLUTE ALTITUDE (AGL)		20,000	20,000	20,000
8	SAFETY FACTOR (HAHO) ACTUATION ALT (HALO)	-	2000	3000	3000
9	DRIVE ALTITUDE (HAHO) HV FALL DIST (HALO)		18,000	17,000	17,000
10	"K" FACTOR		60	3	3
11	BALLISTIC WIND		166/38	164/44	164/44
12	DRIVE DIST (HAHO) HV DRIFT EFF (HALO)	B	17.6NM / 90% - 15.8nm	2244m	2244m
13	ACTUATION ALTITUDE			3000	3000
14	APPROACH FACTOR (Ram-Air/HALO)	-		1000	-
15	DEPLOYED DRIFT DISTANCE (HALO)			2000	3000
16	DEPLOYED BALLISTIC WIND			160/19	160/19
17	DEPLOYED "K" FACTOR			60	25
18	DEPLOYED DRIFT EFFECT (HALO)	B D		1.3nm-2457m / 90% - 1.2nm	1425m
19	DROP ALT TEMPERATURE		-18		
20	IAS/CAS/EAS/TAS		125/124/172		
21	DROP ALTITUDE WIND		150/60		
22	MAGNETIC COURSE		180		
23	DRIFT CORRECTION		-10		
24	MAGNETIC HEADING		170		
25	GROUND SPEED		118		
26	FTT/FTD (4.6 sec)	C	278m		
27	STOP WATCH DISTANCE		800m		
28	STOP WATCH TIME	C	13.2		
29	USABLE DROP ZONE LENGTH (UDZL)		600y		
30	USABLE DZTIME (MINUS 1 secOND)	C	9.0-1=8.0		
31	RED LIGHT TIME		21.2		

PI LAT/LONG OR UTM COORDINATES	N30-41.23 W86-23.70		
PREFLIGHT ALTIMETER SETTING	30.30		
DROP ZONE	C-61A		
SCHEDULED DROP TIME(S)	2100Z		
NUMBER OF JUMPERS/ LOAD WEIGHT	4 / 300#		
PARACHUTE (*Type and number*)	MT1-X/S	MT1-X/S	MC-3
FLIGHT STATION OF LOAD	RAMP		

FORMULAS

A	29.92 / ( ) / + ; (30.30) / 29.92 / - .38
B	Ram-Air (MT1-) D (nm) = (Alt - SF) x (20.8 + V) / "K" Factor x 1000
	MC -1/3 D (meters) = "K" Factor x Altitude x Velocity / 1000'
C	Ground speed / 1.78 (1.95) = Distance - yards (mtrs) / (Time)
D	1 nm = 1852 meters

WIND DATA	PREFLIGHT	INFLIGHT
SFC	150/13	160/10
1000'	160/20	165/17
2000'	NA	165/22
3000'	165/25	170/25
5000'	170/30	170/32
6000'	170/35	175/35
8000'	180/40	175/42
10,000'	175/40	180/47
12,000'	170/42	180/49
14,000'	160/50	180/50
16,000'	150/47	180/50
18,000'	155/55	180/55
20,000'	150/60	180/60

* NOTE: Drive Distance Safety Factor of 90% used in this example.
**NOTE: Inflight Ballistic Wind for HALO Solution only.

"K" Factors
Ram-Air: MT1-X=18, MT1-S=60, MT1 =66
MC-1/3: HV=3, Deployed=25
DROP DATA
GS: 112
Drift: 0
Inflight Ballistic Wind
HV: 178/47**
Deployed 165/18**
WIND LIMIT 17 Kts

AF FORM 4017, MAY 98 (EF-V1)

Replaces AFSOC Form 1, JUL 89, which is obsolete.

5.12. Modified High Altitude High Opening (HAHO) General. The square ram-air parachutes HAHO jumpers use have considerable maneuverability and forward speed. The ram-air parachute design is an air inflated airfoil allowing it to glide in a controlled direction. The jumper operates hand controls that allow turns and attitude changes. Square parachutes have approximately a 8:1 glide ratio; even in still air, these parachutes can travel at a forward speed of 20.8 knots. Three square parachutes are currently in use. The MT1-X is a 7 cell, 370 ft2 canopy with a maximum suspended weight of 450 lbs. It has the slowest descent rate and the highest glide ratio. For this reason, it is normally selected as the main canopy. The MT1-S is slightly smaller (5 cell, 280 ft2 and a maximum suspended weight of 350 lbs) than the MT1-X and is normally used as the reserve parachute. The MT1 is the smallest chute (7 cell, 270 ft2 and a maximum suspended weight of 350 lbs) and has the highest rate of descent. The total time of fall determines how far a parachutist can travel, consequently, the higher the drop absolute altitude, the greater the distance the jumper(s) can travel.

5.12.1. Release Point Considerations. The parachute drive distance is computed at 20.8 knots. In a no wind condition, the drop could be made anywhere inside an imaginary circle with radius equal to the drive distance, and centered on the intended point of impact, **Figure 5.4.** However, wind adds drift distance upwind of the PI, so the drop circle is shifted upwind the distance of the wind drift, figure 5.4b. The PI will be inside the circle unless the average wind speed exceeds the parachute's forward drive velocity of 20.8 knots. On a drop outside of the circle, the parachute drive will not overcome the wind drift, so the jumper cannot reach the PI.

5.12.2. There are two methods of computing a HAHO solution. The first is as follows:

5.12.2.1. The acceptable release area is a circle within which it is possible for the jumper to exit the aircraft and reach the objective area. In a no-wind situation, this area will be centered on the end of the forward travel vector and will have a radius equal to the no-wind parachute glide distance. In a wind condition, two separate computations must be performed. First, compute a no-wind glide distance using "X" in the formula below. Then make another computation using "V" in the same formula. This gives the required distance to move the center of the acceptable release area UPWIND from the PI. A no-wind acceptable release area will be precomputed for each planned drop altitude and will be recomputed for any change in drop altitude. A maximum glide distance will be computed for each drop and will be expressed in nautical miles upwind along the average ballistic wind vector.

5.12.2.2. Use the following formula and contents to compute the HAHO acceptable release area:
(A-2)(V or X)/K = Maximum glide distance in nautical miles
A = AGL drop altitude in thousands of feet (item 7 of AF Form 4015).
V = Wind speed in knots
X = Parachute forward speed (20.8)
K = 48 for MT1X parachutes
60 for MT1S parachutes
66 for MT1 parachutes
Wind drift distance = (A-2)(V/K)
Acceptable release area radius = (A-2)(X/K)
(X/K) = .43333 for MT1X parachute
= .34666 for MT1S parachute
= .31515 for MT1 parachute

5.12.2.3. Use a standard 300 meter forward travel vector.

5.12.3. The second HAHO solution method is as follows:

$$D = \frac{(A - SF) \times (20.8 + V)}{K \times 1000}$$

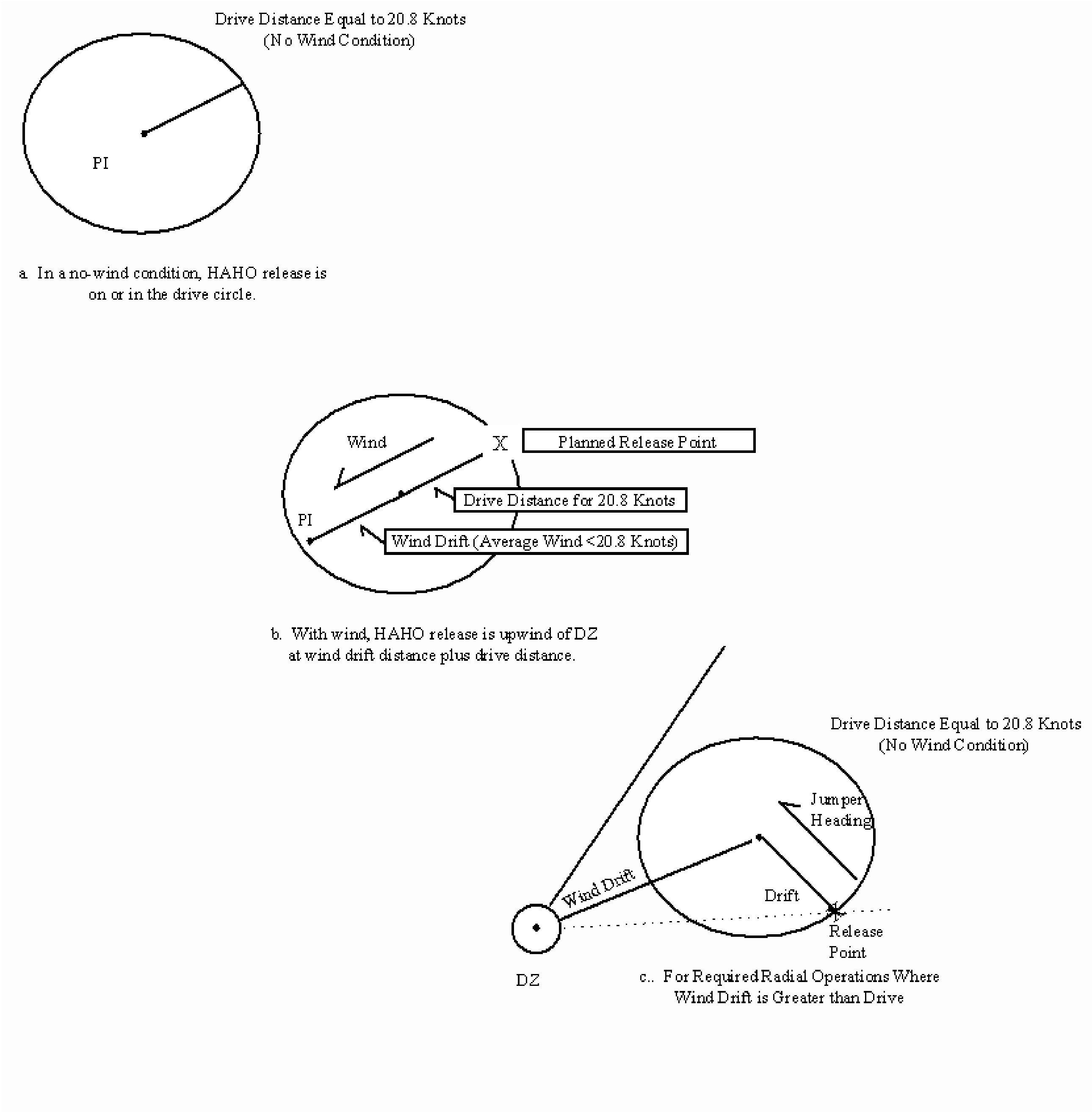
D = Total Drive Distance in nautical miles
A = Absolute Altitude in feet

SF = Safety Factor in feet (A safety buffer from exit to assembly of parachutists under canopy and for assembly at a certain altitude once the "flight" arrives over the drop zone, normally 2,000; 1,000 feet for assembly and 1,000 feet for approach).

20.8 = A Constant for parachute forward velocity
V = Average Wind Velocity in knots
K = Parachute Glide Constant:
= 48 (MT1-X)
= 60 (MT1-S)
= 66 (MT1)

NOTE: The aircrew member must calculate for the lowest performance parachute. If the jumpers are using MT1-X main canopies, but MT1-S reserves, calculate total drive distance using the lower performance (higher K factor) parachute glide constant (i.e., use K = 60 in the above example).

Figure 5.4. HAHO Drive Distance Example.



5.12.3.1. Required Radial HAHO Computations. Tactics may dictate that drops cannot be made on the upwind line. In a situation where the release location is determined by a restricted area, border, or threat ring, plan to drop on a "required radial," figure 5.4c. Pick a radial or sector centered on the point of impact and passing through the allowed area for release. Plot area on a 1:250,000 scale chart or larger. Solve the wind drift vector (in nautical miles) using the formula:

$$D = \frac{(A - SF) \times (V)}{K \times 1000}$$

Plot the wind drift vector on the chart upwind of the point of impact. Next, solve the drive distance (in nautical miles):

$$D = \frac{(A - SF) \times (20.8)}{K \times 1000}$$

Use the drive distance as a radius and plot from the end of the wind line. If the circle crosses the required radial or sector in an area where the drop can be done, then you have an acceptable solution.

5.12.3.2. Plotting Instructions:

5.12.3.2.1. Select a properly scaled chart (1:250,000 scale or larger scale is recommended).

5.12.3.2.2. Plot the total drive distance upwind of the PI using the averaged wind vector. If there is a significant change in wind direction (i.e., a wind shear), it may be necessary to compute the drive distance as two rather than one vector. Should this occur, inform the jumpmaster of where the shear occurs and the desired dogleg headings to optimize drive distance.

NOTE: The aircrew member must examine the parachutists' descent profile in relation to surrounding terrain, if intervening terrain exists, an alternate approach to the drop zone may be required.

5.12.3.2.3. Move the plot the computed FTD in the reciprocal direction of the run-in course to compensate for forward throw. This is the release point.

5.12.4. In-flight AF Form 4015 Completion Requirements. Use the AF Form 4015, High Altitude Release Point Computations, to solve and record in-flight personnel HARP data. Obtain and record actual in-flight winds, if different from preflight, the ballistic winds (averages) used to compute the HARP, and the groundspeed and drift at drop altitude.

5.12.5. Sample Problem:

5.12.5.1. Refer to **Figure 5.2.**, column 1, and the following information:

5.12.5.1.1. Parachute - MT1-X (with a MT1-S reserve)

5.12.5.1.2. Drop Absolute Altitude - 20,000 feet AGL

5.12.5.1.3. Drop Zone Elevation - 250 feet

5.12.5.1.4. "D" Value - +750 feet

5.12.5.1.5. Preflight Altimeter Setting - 30.30 in Hg

5.12.5.1.6. Safety Factor - Team leader desires 1,000 feet, opening delay, and 1,000 feet for approach. Safety factor = 2,000 feet.

5.12.5.1.7. Winds:

20,000ft-150o/60 8,000ft-180^{o}/40

18,000ft-155o/55 6,000ft-170^{o}/35

16,000ft-150o/47 5,000ft-170^{o}/30

14,000ft-160o/50 3,000ft-165^{o}/25

12,000ft-170o/42 1,000ft-160^{o}/20

10,000ft-175o/40 Surface-150^{o}/13

5.12.5.1.8. Magnetic Course - 180^{o}

5.12.5.1.9. Drop Airspeed - 125 KIAS

5.12.5.1.10. Temperature at 20,000 feet = -18^{o}C

5.12.5.2. Solution. The modified HARP solution is completed on AF Form 4015 using the following procedures, refer to **Figure 5.2.**, column 1. Items are self-explanatory except as outlined below:

5.12.5.2.1. Enter the desired drop altitude Item 1, Item 3, or Item 7, as appropriate. Work forward or backward to determine altitude to be flown. Enter 20,000 feet in Item 7 in the above example.

5.12.5.2.2. Item 9. Subtract safety factor Item 8 from Item 7.

5.12.5.2.3. Item 10. Enter the appropriate "K" Factor for the most restrictive parachute used. Since the parachutists are using MT1-S reserves, base "K" Factor on this parachute (i.e., K = 60).

5.12.5.2.4. Record preflight winds in the wind data block on the form.

5.12.5.2.5. Item 11. Enter average of preflight winds. Do not include winds at drop altitude or surface winds in the average, since the first 1,000 feet is normally used for assembly, and the last 1,000 feet is used for approach.

5.12.5.2.6. Item 12. Compute the total drive distance in nautical miles. This block may be split to accommodate an additional team safety factor (i.e., a percentage of the total drive distance). When a safety factor is used, indicate total drive distance, safety factor (percentage) used, and revised drive distance.

WARNING: For HAHO operations, this puts the parachutists at their maximum theoretical drive distance. In the interest of safety, a percentage (e.g., 80%) of the total computed drive distance may be used. When a percentage safety factor is used, split item 12 indicating; the total drive distance, percentage of total drive distance used, and its corresponding value.

5.12.5.2.7. Item 13. Actuation Altitude - The altitude, in feet, above ground level where the parachutist deploys his recovery parachute.

5.12.5.2.8. Item 14. Approach Factor (Ram-Air)(HALO) - The altitude, in feet, above the ground the parachutist desires to be overhead the DZ in order to maneuver for approach. No entry required for MC-1/3 HALO operations.

5.12.5.2.9. Item 15. Deployed Drift Distance (HALO) - The altitude, in feet, the parachutist falls from actuation of recovery parachute and ground level (Item 13 minus Item 14).

5.12.5.2.10. Item 16. Deployed Ballistic Wind - The magnetic wind affecting the parachutist from actuation altitude until ground level.

5.12.5.2.11. Item 17. Deployed "K" Factor - The constant used to calculate drift or drive distance during the deployed phase of flight.

5.12.5.2.12. Item 18. Deployed Drift Effect (HALO) - The drift, in meters, incurred by the parachutist during descent from actuation altitude to the ground.

WARNING: This puts the parachutists at their maximum theoretical drive distance. In the interest of safety, a percentage (e.g., 80%) of the total computed drive distance may be used. When a percentage safety factor is used, split item 18 indicating; the total drive distance, percentage of total drive distance used, and its corresponding value.

5.12.5.2.13. Item 19. Drop Altitude Temperature - The temperature, in degrees Celsius, at the drop true altitude.

5.12.5.2.14. Item 20. IAS/CAS/EAS/TAS - The drop indicated airspeed, equivalent airspeed, calibrated airspeed, or true airspeed as specified in operational regulations; the IAS corrected for pitot-static error, aircraft attitude and instrument error; CAS corrected for compressibility. EAS is determined from aircraft performance data; TAS determined on the DR computer.

5.12.5.2.15. Item 21. Drop Altitude Wind - The forecast magnetic wind at drop altitude.

5.12.5.2.16. Item 22. Magnetic Course - The course from IP to the release point. Obtain from DZ data or depiction.

5.12.5.2.17. Item 23. Drift Correction - Compute on the DR computer using drop altitude wind, TAS, and magnetic course.

5.12.5.2.18. Item 24. Magnetic Heading - The magnetic heading to be flown at parachutist release. Item 22 plus Item 23.

5.12.5.2.19. Item 25. Groundspeed - The preflight groundspeed obtained from the DR computer using magnetic course and TAS.

5.12.5.2.20. Item 26. Forward Travel Time or Forward Travel Distance - The time or distance the parachutist travels along IP-DZ track after green light until reaching terminal velocity. Compute FTD using a FTT of 4.6 seconds, groundspeed and formula C.

5.12.5.2.21. Item 27. Timing Point Distance - The ground distance in yards (meters) measured on the DZ depiction from a ground reference point or from an electronic aid, downtrack to the HARP.

5.12.5.2.22. Item 28. Timing Point Time - The time in seconds that will elapse as the aircraft traverses the timing point distance. Compute using formula C.

5.12.5.2.23. Item 29. Usable DZ Length (UDZL) - The distance in yards from the PI to the end of the DZ.

5.12.5.2.24. Item 30. Usable DZ Time (UDZT) - The UDZL converted to time, in seconds. Compute using formula C.

5.12.5.2.25. Item 31. Red Light Time - The elapsed time from the timing point after which airdrops cannot be made safely. Item 28 plus Item 30.

5.12.5.2.26. Using SCNS for HALO/HAHO Airdrops. Programming the SCNS for a HARP solution requires several additional items which are not on the AF Form 4017. SCNS requires Deployed Rate of Fall (RF, figure 12.14), High Velocity Rate of Fall (Free Fall RF, figure 12.15), Deceleration Time (DT, figure 12.15), Deceleration Distance (DD, figure 12.15), Vertical Distance (VD, figure 12.15), Time of Fall Constant (TFC, figure 12.15), and Forward Travel Time (the sum of ET and DQ, both from 12.15). All other items SCNS requires to compute its HARP solution can be found on the AF Form 4017.

5.13. Modified High Altitude Low Opening (HALO) General. Modified High Altitude Low Opening (HALO) personnel airdrops are similar to a basic CARP solution with an additional free fall/high velocity vector. The MT1 Ram-Air and MC-1/3 paracommander parachutes are normally used. When the Ram-Air parachutes are used, a combination of HAHO and HALO solutions are used in computing the HARP. When the MC-1/3 paracommanders are used, the standard D = KAV/1000 formula may be applied to compute the high velocity and deployed vectors to solve the HARP.

5.13.1. Release Point Considerations. Regardless of the type of parachute used, the high velocity/ free fall drift vector is computed using D = KAV/1000, where K equals a ballistic constant equal to three. The ram-air parachute drive distance is computed as in a HAHO solution using the actuation altitude minus the desired approach altitude. This is an accurate approximation of drift/drive the parachute is capable of in determining the HARP. The same wind velocity considerations discussed in paragraph **5.12.1.** apply. The MC-1/3 paracommanders are round steerable parachutes with limited maneuvering capability. Since these parachutes lack the performance of the ram-air parachutes, the computed drift/drive under canopy is considerably less. Compute the deployed drift using D = KAV/ 1000, with K = 25, and A equal to the actuation altitude, in feet, above ground level. When using the D = KAV method, the forward travel vector must be applied to the equation to determine the HARP.

5.13.2. HALO Computations:

5.13.2.1. The formula D = KAV/1000 is an accurate approximation of drift effect where:
D = drift effect in meters
K = a ballistic constant
A = altitude in feet
V = average wind velocity

WARNING: The forward travel vector must be applied to the D = KAV equation to accurately determine the HARP.

WARNING: The D = KAV/1000 method can be used to compute personnel HALO release points when MC1-1 and MC1-3 parachutes are used. Use the AF Form 4015 to compute and record HARP computation data. When the MT1-X, MT1-S, or MT1 ram-air parachutes are used, a modification of the HAHO formula can be used to calculate the deployed drift/drive, see paragraph 5.3.2.3. Method used will be determined between the aircrew member and the jumpmaster prior to takeoff.

5.13.2.2. MC-1/3 parachutes:

5.13.2.2.1. The HARP computation is divided into three components:

5.13.2.2.1.1. .High velocity drift effect (HVDE). Determined by computing the average wind velocity and direction from exit to opening altitude and using the formula D = KAV/ 1000, where K = 3.

5.13.2.2.1.2. Deployed drift effect (DDE). Determined by computing the average wind velocity and direction from activation altitude to the ground and using the formula D = KAV/1000, where K = 25.

5.13.2.2.1.3. Forward travel distance (FTD). Computed using Item 25, 26 and formula C on the AF Form 4015.

5.13.2.3. Ram-Air Parachutes:

5.13.2.3.1. The HARP computation is divided into three components:

5.13.2.3.1.1. The high velocity/free fall vector is computed as in paragraph **5.13.2.2.1.1.** and the formula D = KAV/1000 as described above.

5.13.2.3.1.2. Deployed drift effect is computed using the HAHO formula:

$$D = \frac{(A - SF) \times (20.8 + V)}{K \times 1000}$$

D = Drive distance in nm

A = Actuation altitude, in feet, above ground level

SF = Safety Factor, in feet (a safety buffer to enable the parachutist to maneuver for DZ approach and landing).

20.8 = A constant for parachute forward velocity

V = Average wind velocity in knots

K = Parachute glide constant:

= 48 (MT1-X)

= 60 (MT1-S)

= 66 (MT1)

Since this equation yields a result in NM, it may be desirable to convert this to meters for ease of plotting (1nm = 1852 meters).

NOTE: The aircrew member must calculate for the lowest performance parachute. If the jumpers are using MT1-X main canopies, but MT1-S reserves, calculate total drive distance using the lower performance (higher K factor) parachute glide constant (i.e., use K = 60 in the above example).

5.13.2.3.1.3. Forward travel distance (FTD). Computed using Item 25, 26, and formula C on the AF Form 4015.

5.13.3. Plotting Instructions:

5.13.3.1. Select a properly scaled chart (1:50,000 scale or larger scale is recommended).

5.13.3.2. Plot the total DDE upwind of the PI using the averaged deployed wind vector.

5.13.3.3. Plot the HVDE upwind from the deployed drift effect plot.

5.13.3.4. Move the plot the computed FTD in the reciprocal direction of the run-in course to compensate for forward throw. This is the release point.

5.13.4. Inflight AF Form 4015 Completion Requirements. Use the AF Form 4015, High Altitude Release Point Considerations, to solve and record in-flight personnel HARP data. Obtain and record actual in-flight winds, the ballistic winds (averages) used to compute the HARP, and the groundspeed and drift at drop altitude.

5.13.5. Sample Problems. **Figure 5.2.**, columns 2 and 3, includes a representative HALO solution for both the ram-air, and paracommander parachutes.

5.13.5.1. Preflight data remains unchanged from paragraph **5.12.4.** with the exception of:

5.13.5.1.1. Actuation altitude = 3,000 feet

5.13.5.1.2. Safety factor (for approach) = 1,000 feet (ram-air only)

5.13.5.1.3. Team Drive Distance Safety Factor = 90%.

5.13.5.2. Solution. The modified HARP solution is completed on AF Form 4017 using the following procedures, refer to **Figure 5.1.**. Items are self-explanatory except as outlined below:

5.13.5.2.1. Enter the desired drop altitude Item 1, Item 3, or Item 7, as appropriate. Work forward or backward to determine altitude to be flown. Enter 20,000 feet in Item 7 in the above example.

5.13.5.2.2. Item 9. Subtract actuation altitude Item 8 from Item 7.

5.13.5.2.3. Item 10. Enter the appropriate "K" Factor for the high velocity portion of the drop (K = 3).

5.13.5.2.4. Record preflight winds in the wind data block on the form.

5.13.5.2.5. Item 11. Enter average of preflight magnetic winds from drop altitude to actuation altitude.

5.13.5.2.6. Item 13. Same as Item 8.

5.13.5.2.7. Item 14. Enter the desired safety factor required for approach maneuvering (Ram-air parachutes only). Enter N/A if MC-1/3s are used.

5.13.5.2.8. Item 15. Actuation altitude Item 13 minus approach factor (ram-air parachutes only) Item 14. Enter actuation altitude if MC-1/3s are used (same as item 13).

5.13.5.2.9. Item 16. Enter average of preflight magnetic winds from actuation altitude to ground level.

5.13.5.2.10. Item 17. Enter the appropriate "K" factor for the deployed portion of the drop (K = 60 for ram-air, K = 25 for paracommander).

5.13.5.2.11. Item 18. Compute and enter the DDE. In the interest of safety, a percentage (e.g., 90%) of the total computed drive distance may be used. When a percentage safety factor is used, split item 18 indicating; the total drive distance, percentage of total drive distance used, and its corresponding value.

5.14. Modified High Altitude CDS, General. High altitude container delivery system airdrops may be conducted as single or two-stage deliveries. A single stage delivery consists of load rigged with a stabilizing, high velocity or reefed parachute that allows the load to descend at approximately 65-250 feet per second. A high velocity CDS, or BLU-82 are examples of single stage airdrops. A two-stage delivery consists of a load rigged with a stabilizing, or reefed parachute allowing the load to descend at approximately 65-250 feet per second to a selected altitude. Once this altitude is reached, a barometric sensing device actuates a timing device or cutter to deploy a larger cargo parachute, or dereef the partially inflated cargo parachute. The confined ballistic system (CBS) and high altitude airdrop resupply system (HAARS) use two-stage recoveries.

5.14.1. High Altitude CDS Computations. The basic high altitude CDS HARP solution is completed on the AF Form 4018, Computed Air Release Point Computations. Computations require a DR computer and an appropriate scale chart or graph paper.

5.14.1.1. Sample Problem #1 (single stage recovery, high altitude CDS) (**Figure 5.4.**, first column):

5.14.1.1.1. Drop altitude = 11,500 feet indicated pressure altitude

5.14.1.1.2. Terrain elevation = 100 feet

5.14.1.1.3. Temperature at drop altitude = + 5^{o}C

5.14.1.1.4. "D" Value = + 500 ft

5.14.1.1.5. IAS = 130 knots

5.14.1.1.6. Parachute - one 26’ ring slot parachute

5.14.1.1.7. Load weight = 2000 lbs

5.14.1.1.8. Ballistics (Chapter 12):

5.14.1.1.8.1. Rate of Fall = 79.2 feet/sec

5.14.1.1.8.2. Vertical Distance = 940 feet

5.14.1.1.8.3. TFC = 8.5 sec

5.14.1.1.8.4. ET (FS 737) = 4.1 sec

5.14.1.1.8.5. DQ = 3.7 sec

5.14.1.2. Solution. The basic CARP solution is completed on the AF Form 4018 using the following procedures:

5.14.1.2.1. Item 5. Pressure altitude - Enter the altitude. In the example - 11,500 feet.

5.14.1.2.2. Item 4. PAV - Enter the "D" Value obtained from weather with the reverse sign.

5.14.1.2.3. Item 3. True altitude - Subtract Item 4 from Item 5.

5.14.1.2.4. Item 2. Terrain elevation - Enter the point of impact elevation.

5.14.1.2.5. Item 1. Drop altitude - Subtract Item 2 from Item 3.

5.14.1.2.6. Item 6, 7, 8 are not required.

5.14.1.2.7. Item 9. True altitude temperature - Enter drop altitude temperature and the temperature at two-thirds drop altitude.

5.14.1.2.8. Item 10. IAS/CAS/EAS - Enter cargo drop airspeed.

5.14.1.2.9. Item 11. TAS - Compute and record TAS using drop altitude temperature.

5.14.1.2.10. Item 12. Rate of fall - Obtain from ballistic data.

5.14.1.2.11. Item 13. Adjusted rate of fall - Compute using two-thirds drop altitude, the temperature at that altitude, and formula C.

5.14.1.2.12. Item 14. Altitude above PI - Same as Item 1.

5.14.1.2.13. Item 15. Vertical Distance - Obtain from ballistic data.

5.14.1.2.14. Item 16. Stabilization altitude - Subtract Item 15 from Item 14.

5.14.1.2.15. Item 17. Time of fall - Compute using formula E.

5.14.1.2.16. Item 18. Time of fall constant - Obtain from ballistic data.

5.14.1.2.17. Item 19. Total Time of fall - Item 17 + Item 18.

5.14.1.2.18. Item 20 - 35 - Self-explanatory.

5.14.1.3. Sample Problem #2 (two-stage delivery, HAARS) (**Figure 5.5.**, second and third columns):

5.14.1.3.1. Drop altitude = 20,000 feet indicated pressure altitude

5.14.1.3.2. Terrain elevation = 350 feet

5.14.1.3.3. Temperature at drop altitude = - 15^{o}C, actuation altitude temperature = + 16^{o}C, surface temperature = + 20^{o}C

5.14.1.3.4. "D" Value = + 500 feet

5.14.1.3.5. IAS = 130 knots

5.14.1.3.6. Parachute - one G-12E parachute

5.14.1.3.7. Load weight = 1500 lbs

5.14.1.3.8. Actuation altitude = 1700 feet AGL

5.14.1.3.9. Ballistics (Chapter 12):

5.14.1.3.9.1. High velocity rate of fall = 203.0 feet/sec

5.14.1.3.9.2. Vertical Distance = 5330 feet

5.14.1.3.9.3. TFC = 18.5 sec

5.14.1.3.9.4. ET (FS 737) = 4.1 sec

5.14.1.3.9.5. DQ = 8.3 sec

Figure 5.5. High Altitude CDS (Single and Two Stage) Examples.

COMPUTED AIR RELEASE POINT COMPUTATIONS — DATE: 1 Sep 01

NAVIGATOR'S NAME (Print)	CALL SIGN	ORGANIZATION	NAVIGATOR'S SIGNATURE
WOOD, JOHNNY	OLD 23	20 AS	Johnny Woods

	FACTORS		STANDARD AND MODIFIED COMPUTATIONS		
1	DROP ALTITUDE		650	20,150	1,700
2	TERRAIN ELEVATION	+	100	350	350
3	TRUE ALTITUDE		12,000	20,500	2,050
4	PRESSURE ALTITUDE VARIATION	+ A	-500	-500	+100
5	PRESSURE ALTITUDE		11,500	20,000	2,150
6	CORRECTED DROP ALTITUDE	B	-	-	1,670
7	TERRAIN ELEVATION	+	-	-	350
8	INDICATED ALTITUDE		-	-	2,020
9	TRUE ALTITUDE TEMPERATURE		+5/+10	-15/+20	+16
10	IAS/CAS/EAS		130	130/132	-
11	TRUE AIRSPEED		159	184	-
12	RATE OF FALL		79.2	203.0	20.8
13	ADJUSTED RATE OF FALL	C	86.2	234.0	21.3
14	ALTITUDE ABOVE POINT OF IMPACT	D	11,900	12,550	1,700
15	VERTICAL DISTANCE	-	940	5,300	1,230
16	STABILIZATION ALTITUDE		10,960	12,550	470
17	TIME OF FALL	E	127.1	53.6	22.1
18	TIME OF FALL CONSTANT	+	8.5	18.5	14.2
19	TOTAL TIME OF FALL		135.6	72.1	36.3
20	BALLISTIC WIND		328/10	170/45	180/15
21	DRIFT EFFECT	F	762	1,823	306
22	DROP ALTITUDE WIND		260/30	160/55	-
23	MAGNETIC/TRUE COURSE		260		-
24	DRIFT CORRECTION		-0		-
25	MAGNETIC/TRUE HEADING		260		-
26	GROUND SPEED		129		-
27	EXIT TIME		4.1		-
28	DECELERATION QUOTIENT	+	3.7		-
29	FORWARD TRAVEL TIME		7.8		-
30	FORWARD TRAVEL DISTANCE	G	565		-
31	STOP WATCH DISTANCE		-	-	-
32	STOP WATCH TIME	H	-	-	-
33	USABLE DROP ZONE LENGTH	I	800		-
34	USABLE DROP ZONE TIME	H	11.0		-
35	RED LIGHT TIME (32 + 34)		11.0		-

PREFLIGHT ALTIMETER SETTING	29.92	29.92	
DROP ZONE	RODEO	BUNKER	
SCHEDULED DROP TIME(S)	1800Z	2200Z	
LOAD	HV CDS	HAARS	
LOAD WEIGHT	2000#	1500#	
PARACHUTE (*Type and number*)	26 ft RS	G-12E	
FLIGHT STATION OF LOAD	737	737	

FORMULAS

A	29.92 / 29.82 / +0.1	29.92		
B	Temperature / Pressure Altitude = Drop Altitude / (Corrected Drop Altitude) (ALTITUDE WINDOW)			
C	Average Temperature / Average Pressure Altitude = (Adjusted Rate of Fall) / Rate of Fall (DENSITY ALTITUDE WINDOW)			
D	True Altitude	12,000	20,000	2,050
	Minus Point of Impact Elevation	100	2,150	350
	(Altitude above Point of Impact)	11,900	17,850	1,700
E	Adjusted Rate of Fall / Stabilization Altitude = 1.0 / (Time of Fall)			
F	Total Time of Fall / 1.78 (1.94 Mtr) = (Drift Effect) / Wind Speed			
G	Groundspeed / 1.78 (1.94 Mtr) = (Forward Travel Distance) / Forward Travel Time			
H	Groundspeed / 1.78 (1.94 Mtr) = Distance / (Time)			
I	Usable DZ Remaining (PI to TE)	900	900	
	Minus Safety Zone Distance	100	100	
	Usable Drop Zone Length	800	800	

RD CA RT DA	SURFACE WIND			
	MEAN EFFECTIVE WIND			
	ALTITUDE WIND			
DROP DATA	BALLISTIC WIND USED (M) (I)			
	GROUNDSPEED (C) (D) (S)			
	DRIFT (C) (D) (S)			
	GREEN LIGHT TIME (S) (V)			
	RED LIGHT TIME			
RESULTS	TOT			
	FORMATION POSITION (S) (V)			
	RAW CIRCULAR ERROR			
	CORRECTED CIRCULAR ERROR			

AF FORM 4018, MAY 98 (LRA-V1) Replaces AMC FORM 512, Apr 93, which is obsolete.

5.14.1.3.9.6. Deceleration Distance = 1230 feet

5.14.1.3.9.7. Deployed rate of fall = 20.8 feet/sec

5.14.1.3.9.8. Deceleration Time = 14.2 sec

5.14.1.4. Solution. The basic HARP solution is completed on the AF Form 4018. One column is used for the high velocity portion of the recovery, and a separate column is used for the deployed portion. The following designations are used throughout this solution: 1) - designates entry in the high velocity column (first column), and 2) - designates entry in the deployed column (second column):

5.14.1.4.1. Item 5. Pressure altitude - 1) Enter the drop indicated altitude. 2) Start with Item 1 - Enter actuation altitude (AGL).

5.14.1.4.2. Item 4. PAV - 1) Enter the "D" Value obtained from weather with the reverse sign. 2) Enter pressure altitude variation computed using preflight altimeter setting and formula A.

5.14.1.4.3. Item 3. True altitude - 1) Subtract Item 4 from Item 5. 2) Add Item 1 + Item 2.

5.14.1.4.4. Item 2. Terrain elevation - Enter the point of impact elevation.

5.14.1.4.5. Item 1. Drop altitude - 1) Subtract Item 2 from Item 3. 2) Enter actuation altitude AGL.

5.14.1.4.6. Item 6. Corrected drop altitude - 1) Not required. 2) Compute using formula B.

5.14.1.4.7. Item 7. Terrain elevation - 1) Not required. 2) Same as Item 2.

5.14.1.4.8. Item 8. Indicated altitude - 1) Not required. 2) Item 6 + Item 7.

5.14.1.4.9. Item 9. True altitude temperature - 1) Enter drop altitude temperature and the surface temperature. 2) Enter temperature at actuation altitude.

5.14.1.4.10. Item 10. IAS/CAS/EAS - 1) Enter cargo drop airspeed. 2) Not required.

5.14.1.4.11. Item 11. TAS - 1) Compute and record TAS using drop altitude temperature. 2) Not required.

5.14.1.4.12. Item 12. Rate of fall - 1), 2) Obtain from ballistic data.

5.14.1.4.13. Item 13. Adjusted rate of fall - 1), 2) Compute using formula C.

5.14.1.4.14. Item 14. Altitude above PI - 1) Compute using formula D and pressure altitude Item 5 minus actuation pressure altitude Item 5,-2). 2) Compute using formula D and actuation true altitude Item 3,-2) minus point of impact elevation Item 2,-2).

5.14.1.4.15. Item 15. Vertical Distance - 1) Obtain from ballistic data (vertical distance). 2) Obtain from ballistic data (deceleration distance).

5.14.1.4.16. Item 16. Stabilization altitude - 1), 2) Subtract Item 15 from Item 14.

5.14.1.4.17. Item 17. Time of fall - 1), 2) Compute using formula E.

5.14.1.4.18. Item 18. Time of fall constant - 1) Obtain from ballistic data (time of fall constant). 2) Obtain from ballistic data (deceleration time).

5.14.1.4.19. Item 19. Total Time of fall - 1), 2) Item 17 + Item 18.

5.14.1.4.20. Item 20. Ballistic wind - 1), 2) Self-explanatory.

5.14.1.4.21. Item 21. Drift effect - 1), 2) Compute using formula F.

5.14.1.4.22. Item 22 - 35 - 1) Self-explanatory. 2) Not required.

5.14.2. Plotting Instructions:

5.14.2.1. Select a properly scaled chart (1:50,000 or larger recommended), or if no large scale charts are available, graph paper may be substituted.

5.14.2.2. Plot the drift effect distance upwind of the PI using the average wind vector.

5.14.2.3. For two-stage deliveries only - Plot the high velocity drift effect distance upwind of the deployed drift effect plot using the average wind vector.

5.14.2.4. Move the plot the computed FTD in the reciprocal direction of the run-in course to compensate for forward throw. This is the release point.

5.14.3. Inflight AF Form 4018 Completion Requirements:

5.14.3.1. The recorded data section is provided to record winds at the DZ reported from ground sources.

5.14.3.2. The drop data section will contain data actually used to make the airdrop.

5.14.3.3. Items 20 through 35 should be recomputed in-flight using the most current winds available

Chapter 6

SPECIAL PROCEDURES

6.1. Ground Radar Aerial Delivery System (GRADS) , **General.** GRADS was developed to provide an all weather system for aerial delivery using a ground radar to position the aircraft at an air release point. This system is currently not in use. However, this paragraph will serve as an historic document for future operational use. Two radar systems are available for positioning, the SEEK POINT (TBP-1) and the SKY SPOT (MSQ-77 or equivalent). The SKY SPOT is the radar system used during RBS-directed airdrops.

6.1.1. GRADS Terms:

6.1.1.1. Acquisition Point. A preplanned point at which the ground based radar will acquire the aircraft and commence guidance.

6.1.1.2. Miss Distance. The lateral distance from the planned CARP or HARP to the aircraft's actual position at release, as measured by the ground radar providing guidance.

6.1.2. GRADS Procedures:

6.1.2.1. Complete the applicable CARP or HARP computations. When plotting FTD and drift effect on a graph or a DZ depiction with a meter scale, it may be desirable to convert these values, in yards, to meters by using the formula:

$$\frac{.914}{1.0} = \frac{\text{(meters)}}{\text{yards}}$$

6.1.2.2. Plot the CARP or HARP and determine its position in terms used by the radar controller. See **Figure 6.1.**

6.1.2.2.1. SEEK POINT: The aircraft position will be expressed in distance north or south and distance east or west from the PI. Insure the position is based on true cardinal directions. Since the winds and course used on the AF Form 4018 are magnetic, draw a magnetic north line on the depiction for use in plotting wind vectors and the DZ axis.

6.1.2.2.2. SKY SPOT: The aircraft position will be expressed as true bearing and distance to the PI.

6.1.2.3. The selection of the type DZ depiction is left up to the navigator and may be based on availability of map, photo, etc., coverage. Graph paper is acceptable, especially for IMC or night drops when ground features are obscured or unavailable and when aircraft altitude limits their usefulness.

6.1.3. Sample Problem:

DZ Axis = 360o Mag or 010^{o} True

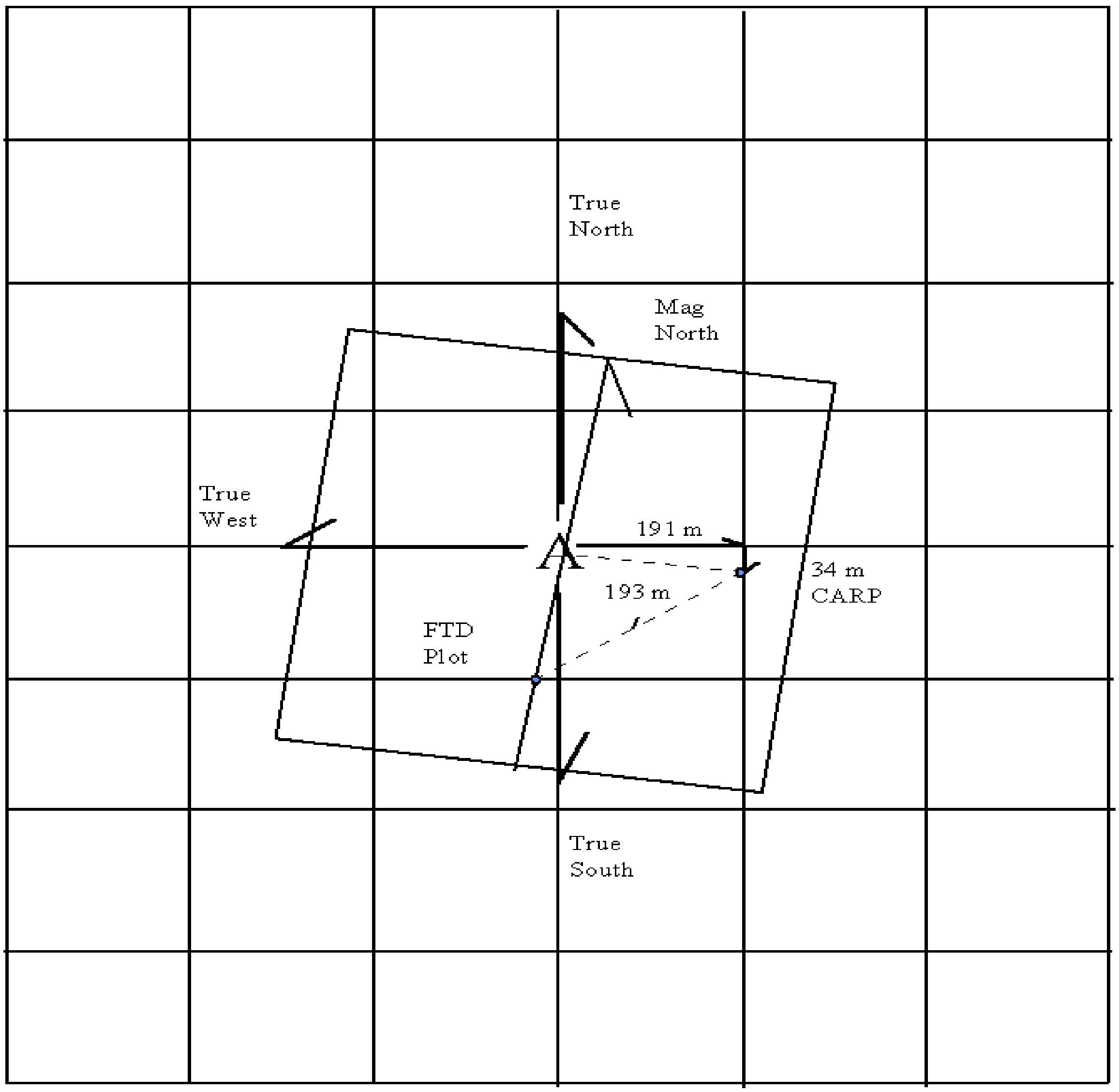
Drop Wind Direction = 044^{o} Mag

Drift Effect =300 yds(274 meters)

FTD = 212 yds (194 meters)

The CARP for the SEEK POINT controller would be relayed as 34 meters south, 191 meters east. The same CARP will be relayed to a SKY SPOT controller as 100o at 627 feet. Specific terminology will be IAW operational procedures.

Figure 6.1. GRADS Graph Sample.



6.2. Radar Beacon Delivery Procedures, General. Radar I, J and K-Band transponder beacons provide a positive means to locate, recognize and align on the DZ, LZ, or RZ. Airborne radar approaches and airdrops can be accomplished successfully by using the beacon as a terminal reference. Note: C-17s, see T.O. 1C-17A-1-2 for Radar Beacon Delivery Procedures.

6.2.1. Beacons are omni-directional or directional, depending on beacon and mode selected. Normal aircrew procedures for airdrop and airland are not affected by the use of radar beacons as a terminal reference.

6.2.2. Equipment:

6.2.2.1. The SST-181X (UPN-25) radar beacon transponder is a line-of-sight receiver and pulse transmitter operating in the I-Band frequency range. The radar beacon provides identification by either a coded pair of output pulses or a single pulse. The double pulse can be coded with distances between pulses from 4 to 12 nm. This provides 10 different combinations which the reception committee can set to control the pulse coding that appears on the aircraft radar. When double pulse is used, the innermost radar return is used for range and bearing determination. The outermost return is for authentication.

6.2.2.2. The GAR/I radar beacon transponder is a line-of-sight receiver and pulse transmitter operating in the I, and K-Band frequency ranges. A Ka-Band signal triggers the transmitter which responds with a series of I-Band pulses. The first pulse provides range and bearing, the subsequent pulses (up to four) are for authentication. The transponder is set for horizontal and linear polarization and has an antenna pattern of 25 degrees azimuth and 50 degrees elevation either side of centerline. Effective range is 20 nm under optimum conditions.

6.2.2.3. The PPN-19 radar beacon transponder is a line-of-sight receiver and pulse transmitter operating in the I, K, or J-Band frequency ranges. The PPN-19 can provide omni-directional or directional radiation capability. There are seven operator selectable codes, and four selectable transmit modes. The PPN-19 can receive and transmit in I-Band, J-Band, I and J-Bands simultaneously, or receive K-band and transmit in I-Band (GAR/I). The first pulse provides range and bearing, with subsequent pulses provided for authentication.

6.2.3. Problems and Solutions:

6.2.3.1. Scope ringing should be anticipated at close range to the SST-181X (UPN-25) beacon. This phenomenon is caused by the increased energy received from the beacon at close range. Scope ringing can be minimized by reducing radar gain and adjusting antenna tilt. Ringing is dependent upon a multitude of factors; however, as a general rule of thumb, ringing can be expected at the following ranges for the selected altitudes:

ALT (AGL)	RANGE
1,500 feet	1.5 nm
1,200 feet	1.0 nm
1,000 feet	0.8 nm
500 feet	0.6 nm
300 feet	0.5 nm
150 feet	0.1 nm

Anticipation of scope ringing is important for two reasons. First, it is necessary to be established on the final drift corrected heading prior to scope ringing. Second, release timing for airdrops must begin before the radar pulse is obscured by ringing. Therefore, timing for release should begin, or the final update for AUTOCARP should be inserted, before the beacon return starts to ring. Timing should be initiated or restarted at the nearest forward range to improve accuracy.

6.2.3.2. Slant range versus ground range needs to be clearly understood. Slant range is the straight line distance between the aircraft and target. Ground range is the distance from the point on the earth's surface directly below the aircraft to the target. The radar provides slant range.

Unfortunately, ground range is required for beacon computations. The slant range correction distance for various altitudes and ranges is listed in **Figure 6.2.**

NOTE: Applies to slant-range radar displays only.

6.2.4. Beacon Placement and Timing:

6.2.4.1. Standard beacon placement procedures for the ground reception committee are in Joint Publication 3-05.1. The tactical environment will frequently require modification of these standard placements. Ensure that both the ground reception committee and the aircrews are briefed where beacons are placed.

6.2.4.2. Timing Point Timing. Because the possibility for scope ringing exists, timing point timing to the release point must be calculated for pessimistic and optimistic ranges (normally 2 and 1 nm).

NOTE: The APQ-170 radar set (MC-130H) corrects the beacon return to ground range prior to display, using standard beacon delay values (1.0 microseconds for I-band, 0.3 microseconds for J-band). Therefore, no range correction is required unless a non-standard beacon delay is used.

6.2.4.3. Sample Problem:

Drop Alt = 1000 feet AGL

Drop Groundspeed = 130 knots

6.2.4.3.1.	For 1 nm:	= 2025 yds	1832 yds @ 130 knots	= 25.1 secs
	Beacon delay	= -166 yds	FTT	= -3.2 secs
	Slant Range Error	= - 27 yds	Stopwatch timing	= 21.9 secs
	Total	= 1832 yds		
6.2.4.3.2.	For 2 nm:	= 4050 yds	3870 yds @ 130 knots	= 53.0 secs
	Beacon Delay	= -166 yds	FTT	= -3.2 secs
	Slant Range Error	= -14 yds	Stopwatch timing	= 49.8 secs
	Total	= 3870 yds		

This solves for the range problem, if there is a considerable cross track offset, this distance can be computed and set using either the mechanical or electronic cursor to establish the proper inbound track. If, as in the above example, the CARP plotted 300 yds right of the beacon placement, the radar offset distance would be:

Offset = 300 yds

Slant Rng Corr for 300 yds @ 1000’ AGL= 170 yds

Total (Required Scope Offset) = 470 yds

Figure 6.2. Slant Range Correction Values.

ALT(ft)	0nm	.2nm	.4nm	.6nm	.8nm	1nm	2nm	3nm	4nm	5nm	10nm
200	67	5	3	2	1	1	1	0	0	0	
300	100	12	6	4	3	2	1	1	1	0	
400	133	21	11	7	5	4	2	1	1	1	
500	167	33	17	11	9	7	3	2	2	1	
600	200	47	24	16	12	10	5	3	2	2	
700	233	62	33	22	17	13	7	4	3	3	
800	267	80	43	29	22	17	9	6	4	4	
900	300	99	54	36	28	22	11	7	6	4	
1000	333	120	66	45	34	27	14	9	7	5	
1100	367	141	79	54	41	33	17	11	8	7	
1200	400	164	93	64	49	39	20	13	10	8	
1300	433	188	109	75	57	46	23	15	12	9	
1400	467	213	125	87	66	53	27	18	13	11	
1500	500	238	142	99	75	61	31	21	15	12	
1600	533	265	160	112	86	69	35	23	18	14	
1700	567	291	179	126	96	78	39	26	20	16	
1800	600	319	198	140	108	87	44	30	22	18	
1900	633	347	218	155	119	97	49	33	25	20	
2000	667	375	239	171	132	107	54	36	27	22	
3000	1000	674	477	359	284	233	122	82	61	49	
4000	1333	988	750	589	478	399	214	145	109	87	
5000	1667	1310	1043	847	704	598	329	224	170	136	
6000	2000	1636	1348	1125	954	821	467	321	243	196	
7000	2333	1963	1660	1416	1220	1064	624	433	329	265	
8000	2667	2292	1977	1715	1500	1323	799	559	428	345	
9000	3000	2622	2297	2022	1789	1594	990	700	538	435	
10000	3333	2953	2620	2333	2086	1875	1195	854	659	534	
11000	3667	3284	2945	2648	2388	2163	1413	1021	791	643	
12000	4000	3615	3271	2965	2695	2458	1642	1198	934	761	
13000	4333	3947	3598	3285	3006	2758	1881	1387	1086	888	
14000	4667	4279	3926	3607	3320	3062	2129	1585	1248	1024	
15000	5000	4611	4255	3930	3636	3369	2384	1793	1419	1167	
16000	5333	4944	4584	4255	3954	3680	2646	2009	1598	1319	
17000	5667	5276	4914	4580	4273	3992	2915	2232	1785	1478	
18000	6000	5609	5244	4907	4595	4307	3189	2463	1980	1644	
19000	6333	914	5575	5234	4917	4624	3467	2701	2182	1817	
20000	6667	6274	5906	5561	5240	4942	3750	2944	2390	1997	1069
21000	7000	6607	6237	5889	5565	5262	4037	3193	2605	2184	
22000	7333	6939	6568	6218	5890	5583	4327	3447	2826	2376	
23000	7667	7272	6899	6547	6216	5904	4620	3706	3053	2575	
24000	8000	7605	7231	6877	6542	6227	4916	3970	3284	2779	
25000	8333	7938	7562	7206	6869	6551	5215	4237	3521	2988	1637

6.3. BLU-82B/C-130 Weapon System Delivery Procedures, General. The BLU-82B/C-130 weapon system, nicknamed Commando Vault, is the high altitude delivery of a 15,000 pound general purpose bomb from a C-130. This system depends upon the accurate positioning of the aircraft by either a fixed ground radar or onboard navigation equipment. The ground radar controller or aircrew navigator as applicable, is responsible for positioning the aircraft prior to final countdown and release. Primary aircrew considerations include accurate ballistic and wind computations provided by the navigator, and precision instrument flying with strict adherence to controller instructions. The minimum altitude for release due to blast effects of the weapon is 6,000 feet AGL. A HARP will be completed by the aircrew for each drop using the procedures in **Chapter 5** and as outlined below.

6.3.1. Computations:

6.3.1.1. The AF Form 4018, Computed Air Release Point Computations, will be used to solve the HARP. Generally, the same procedures apply as for other single stage high velocity drops (refer to **Chapter 5** for form completion requirements).

6.3.1.2. The determination of a mean effective ballistic wind involves averaging of both azimuth and velocity at intermediate altitudes between drop altitude and the surface to determine the ballistic wind to be used in the release point computation.

6.4. C-130 Sight Angle Airdrop Technique. Sight angle dropping is based on a visual release using the point of impact marking as the visual computed air release point. A basic understanding of the sight angle dropping theory is necessary to grasp the concept of airdropping from different altitudes. These techniques are provided as a basis to work from and do not preclude units from modifying or developing alternate methods.

6.4.1. The theory behind sight angle dropping is the geometrical triangle. The three sides of the triangle are the altitude above the point of impact, the release point distance short of the point of impact and the line of sight from the aircraft to the point of impact, **Figure 6.3.** The angle used to determine the release point is the angle formed by the sides "line of sight" and "altitude above PI", **Figure 6.3.** The "altitude above PI" is calculated by adding the drop altitude to the drop zone highest elevation minus the point of impact elevation, or by using the "altitude above point of impact" from Item 14 on the AF Form 4018. The "distance short of PI" is the airdrop forward travel distance corrected for the wind vector. Once the altitude above the PI and the distance short of the PI are determined, the sight angle may be calculated.

6.4.2. Preflight:

6.4.2.1. Compute the (CARP) on the AF Form 4018 as normal.

6.4.2.1.1. Plot the location of the CARP relative to the PI on a blank sheet of paper (or graph paper if available) using any appropriate scale.

6.4.2.1.2. Determine the distance (in yards) the CARP falls prior to, or after, the PI. This becomes the CARP distance or forward travel distance corrected for wind.

6.4.2.2. Depression Angle Calculations Method One:

6.4.2.2.1. **Figure 6.4.** gives the depression angle for a given forward travel distance and altitude above the point of impact. Enter the chart with both the distance above the PI and the forward travel distance corrected for wind. The resultant angle is the sight angle or depression angle for the airdrop.

NOTE: For CDS drops where the aircraft is normally flown with 7^{o} nose up attitude, you must subtract this deck angle from the angle extracted from **Figure 6.4.**

6.4.2.2.2. Translate this angle to a visible reference in the cockpit. There are numerous ways to do this; marking the foot pedal windows with a grid to equate to yardage, using either a plotter or a clinometer to measure the angle and mark the reference point with a grease pencil or visual aid marker. The easiest method for measuring the angle in the cockpit is by using the plotter. All that is required is the plotter, string and a weight. Set up the plotter by threading the string through the center of the plotter and tie the weight to the string. The plotter is properly set up if when looking horizontally down the edge of the plotter, the weighted string measures 90 degrees on the plotter compass and 0 degrees looking vertically at the ground.

6.4.2.3. Depression Angle Calculations Method Two:

6.4.2.3.1. At the aircraft, determine the airdrop sight angle using a simple ratio:

$$\frac{\text{eye altitude above the ground*}}{\text{planned airdrop altitude}} = \frac{\text{pace distance}}{\text{CARP dist}}$$

NOTE: Eye altitude above the ground is the sum of the height of the aircraft floor and the navigator's height in his airdrop crouch or whatever position he plans to release from. All C-130s are 7'11" from cockpit floor to tarmac. Example: With the navigator's head next to the corner of the flight engineer's overhead panel, his eye is 5'7" from the floor. Therefore, use 13.5' as eye altitude above the ground.

Figure 6.3. Sight Angle Triangle.

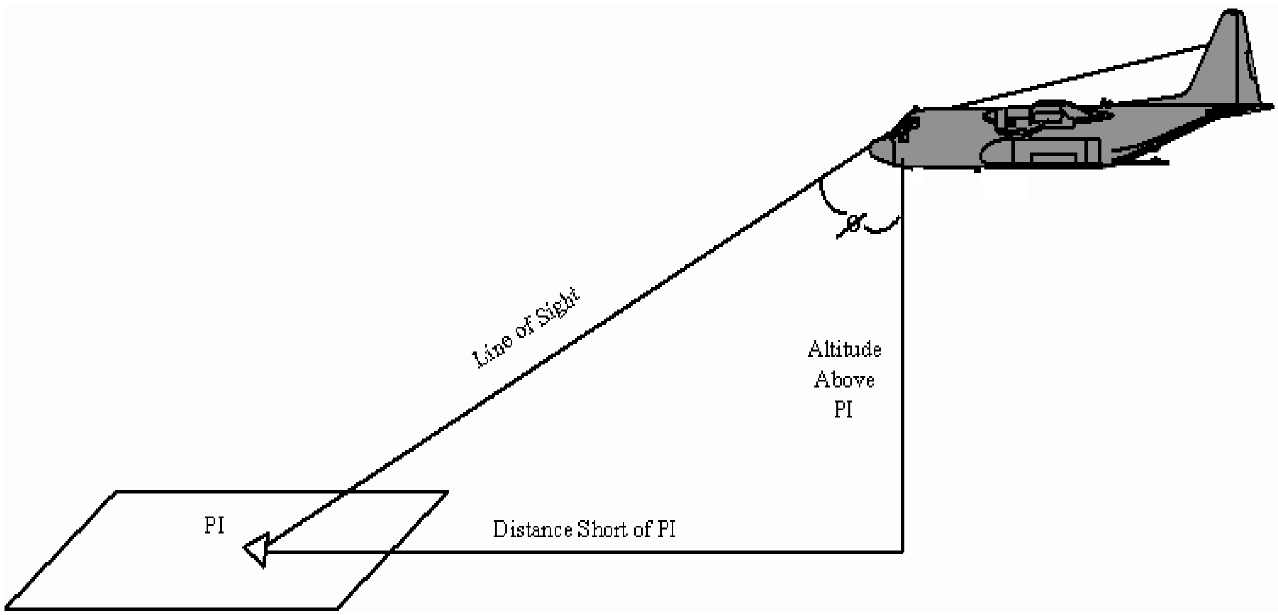
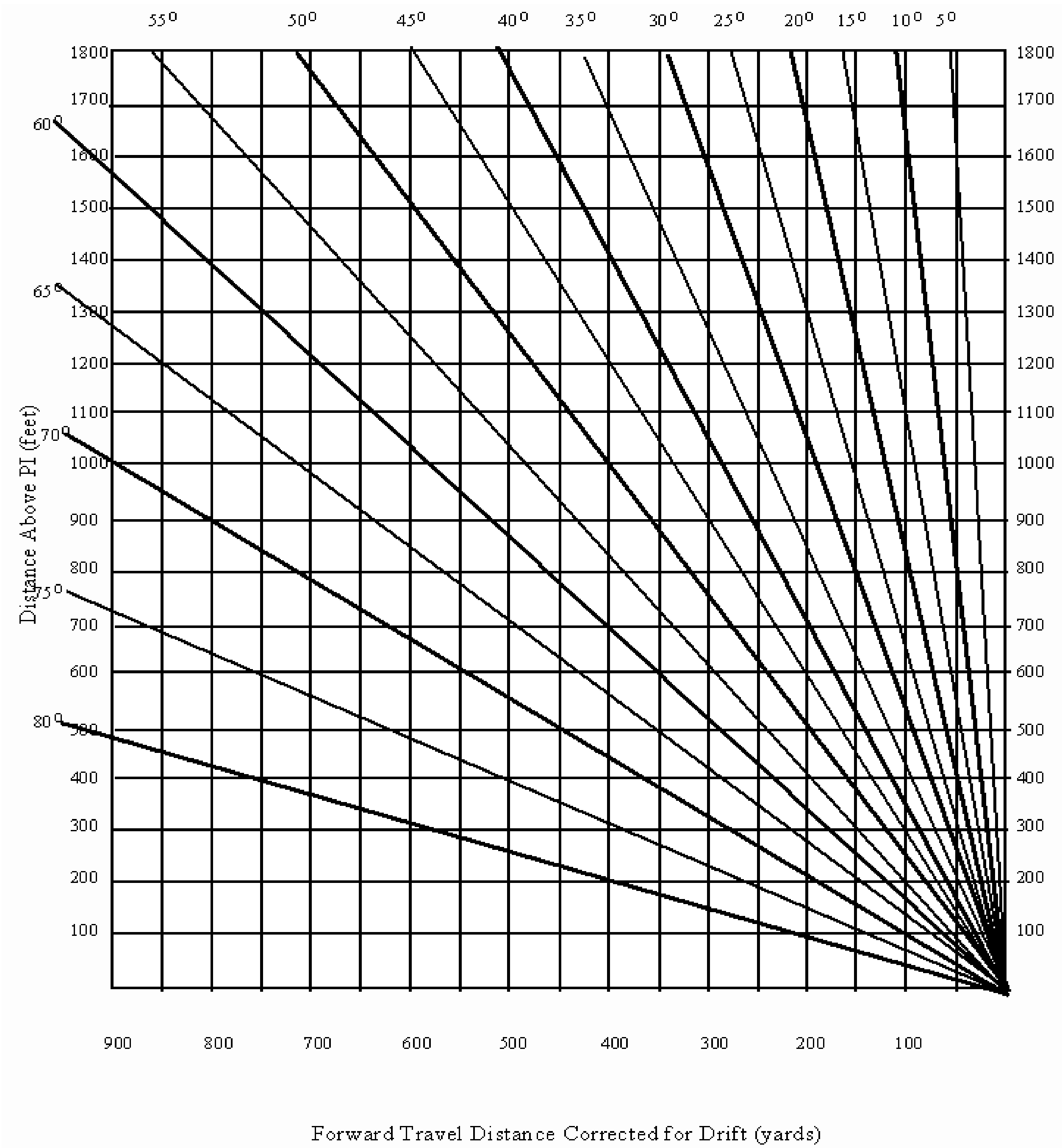


Figure 6.4. Depression Angle Chart.



6.4.2.3.2. Compute and record the pace distance for personnel or equipment airdrops using the ratio described above.

NOTE: For CDS airdrops, a correction must be applied for the increased deck angle. For CDS airdrops at 600 feet AGL, subtract 128 yards from the CARP distance plot and compute pace distance, as described.

6.4.2.3.3. Starting at the aircraft forward jack stand location, measure the pace distance, determined using the formula described above, and mark the position with a checklist, briefcase or whatever (either step it off or know the size of the ramp concrete squares). Repeat the procedure, pacing the same distance at an angle as shown in **Figure 6.5.**(the angle selected is not critical, but must be sufficient to account for any expected aircraft drift on approach to the DZ). The two markers can be referred to as “scaling markers.”

6.4.2.3.4. With the two scaling markers in place, return to the aircraft cockpit. With your head in the same position from which the airdrop will be made (e.g., against the bend in the flight engineer's overhead panel), sight through the appropriate window to the first scaling marker. Place a grease pencil mark on the window at the intersection point. Repeat this for the other scaling marker. Connect the two window grease pencil marks with a line (note that the line slopes up somewhat from the nose of the aircraft to the aft). This is the "green light" line for that particular airdrop.

6.4.2.3.5. To avoid having to scramble when in-flight conditions change the CARP location, one technique is to reaccomplish the appropriate steps for groundspeeds ten knots higher and lower than planned. Plot the 10 knot high and low "green light" adjustment lines above and below the preflight "green light" line. You may also consider repeating the above procedures for the left side of the cockpit as well.

6.4.2.4. Inflight Actions. The navigator updates the CARP location and advises the pilot of the revised location. The pilot is responsible for maintaining the desired lateral displacement offset. The navigator makes minor corrections to his "green light" line and positions himself in the airdrop position on which the preflight was based. He watches the PI or timing point and call "green light" or starts his stopwatch timing when the point passes through the line.

6.4.2.5. Error Sensitivity. Accurately positioning the aircraft at the release point is the most critical phase of the airdrop mission. Sight angle airdrop methods reduce the possibility of gross airdrop errors; however, the sight angle method is only as accurate as the geometry used. Examples of error and resultant effect on aircraft positioning relative to the PI include:

6.4.2.5.1. Head Positioning. If the eye is one inch from its intended position, the resultant sight angle error is (in yards):

CDS	PERSONNEL	HE
19.1	6.8	14.3

6.4.2.5.2. Aircraft Altitude Error. If the aircraft is 10 feet above or below proper altitude, the airdrop resultant sight angle error is (in yards):

CDS	PERSONNEL	HE
8.7	3.5	6.4

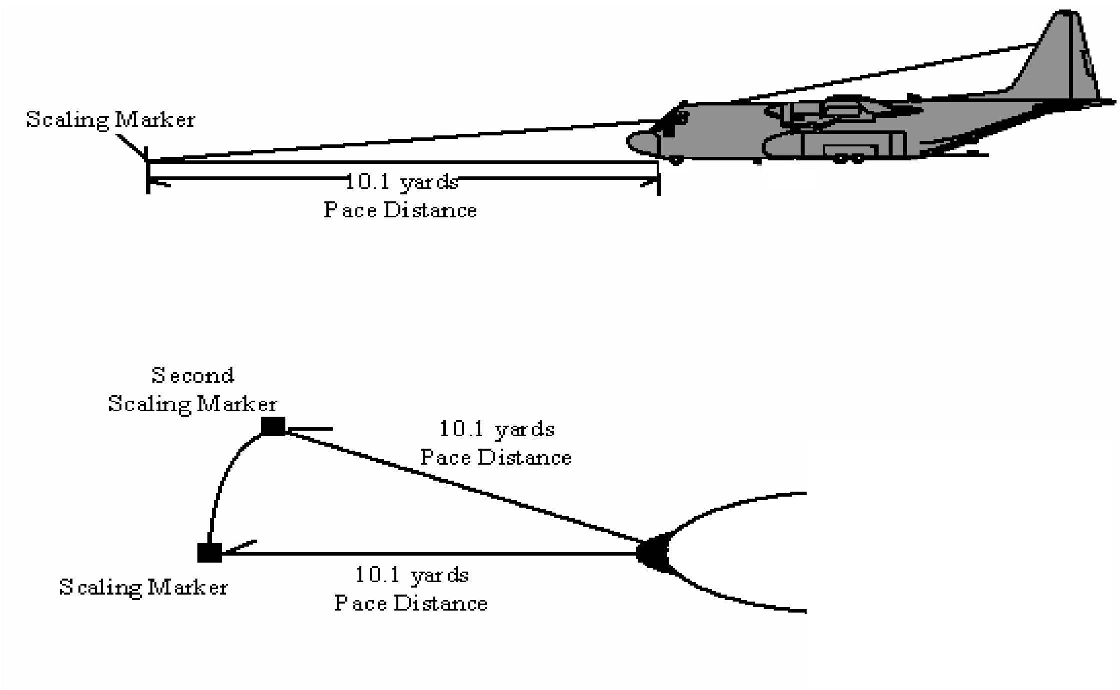
6.4.2.5.3. Aircraft deck angle error. If the aircraft deck angle is 1 degree off, the resultant sight angle error is (in yards):

CDS	PERSONNEL	HE
28.0	9.9	20.9

6.4.2.5.4. Pacing error. If a 1 yard pacing error is made during preflight, the resultant sight angle error is (in yards):

CDS	PERSONNEL	HE
44.4	59.3	55.6

Figure 6.5. Placement of Scaling Markers.



6.5. Forward Looking Infrared (FLIR) Airdrop Techniques (MC-130).

6.5.1. General. The FLIR may be used to determine the release point on blind or marked DZs as the primary airdrop method or as an alternative to a planned AUTOCARP. Improved accuracy on airdrops can be obtained by performing the line-up visually and accomplishing the release on the FLIR.

6.5.2. Preflight Procedures. Complete the AF Form 4018 IAW **Chapter 3**. Plot the CARP. Convert the 10 second warning time to yards using formula H and enter the result at the bottom of the column, **Figure 6.7.** Plot the location of the 10 second warning on the DZ diagram, if able. Divide Items 31 and 32 in two as shown in **Figure 6.7.** The top half of each item is used for the 10 second warning and the bottom half for the CARP. If these items are already in use for visual timing information, use an adjacent column for the FLIR data. Using all available imagery and chart information and the criteria below, select FLIR targets for line-up and release and annotate on a DZ photo, mosaic, diagram, or run-in chart (JOG or larger scale preferred):

6.5.2.1. Line-up Targets. The line-up targets chosen must be prominent enough to allow positive identification early enough to allow final line-up corrections to be made using the FLIR alone, making allowance for the limited field of view and the difficulty of judging aircraft track relative to the FLIR monitor presentation. The line-up targets may be beyond the PI, short of the PI, or the PI itself. If available, select two or more line-up targets so that the line-up may be judged by comparing their relative positions. Additional targets between the IP and the DZ should also be selected as an aid in maintaining course centerline and acquiring the DZ.

6.5.2.2. Release Targets. The 10 second warning and release may be accomplished by one of three methods; depression angle (**Figure 6.6.**), azimuth (**Figure 6.7.**), or timing (**Figure 6.8.**). Different methods and targets may be required for the 10 second warning and the CARP, depending on the location of each. Depression angle is the primary method. The azimuth method is used to avoid the possibility of not reaching the calculated depression angle due to a line-up error when the 10 second warning location or the CARP is too close to the FLIR target. To determine which method to use, plot two lines from the FLIR target at 50 degrees either side of the DZ course (**Figure 6.7.**, and **Figure 6.8.**). Use the azimuth method to determine the 10 second warning or the CARP if either falls in the sectors abeam the target, otherwise use the depression angle method. The timing method is least preferred and should only be used when adequate targets are not available in the DZ area or when the depression angles for either the 10 second warning or the CARP are less than approximately 10 degrees. Because of the high groundspeed and low drop altitude (resulting in a low FLIR depression angle) used for HSLLADS, the timing method is best suited for determining the HSLLADS 10 second warning.

6.5.2.2.1. Depression Angle Method. Select an easily identifiable target as close to DZ centerline as possible. Measure the direct distance, in yards, from the FLIR target to the 10 second warning location or the CARP and enter in Item 31. Using the corresponding distance in Item 31, obtain the depression angle value of the warning or the CARP from **Figure 6.4.**, subtract this value from 90 degrees, and enter the result in Item 32 as appropriate (**Figure 6.6.**).

6.5.2.2.2. Azimuth Method. Enter "AZ" in Item 31, in the section (10 second warning or CARP) that the azimuth method is used for. Measure the relative bearing to the FLIR target at the 10 second warning or CARP location and enter along with the direction in Item 32 (**Figure 6.7.**).

6.5.2.2.3. Timing Method. Select an easily identifiable target between the 10 second warning location and not more than two minutes prior to the CARP. Calculate the distance in yards from abeam the target to the warning location or CARP and enter in Item 31. Convert this distance to timing point time using formula H and enter in Item 32. If both the warning and the CARP will be determined using the timing method, omit the top half of Item 31 and compute the top half of Item 32 by subtracting 10 seconds from the bottom half of Item 32 (**Figure 6.8.**).

6.5.3. Inflight Procedures.

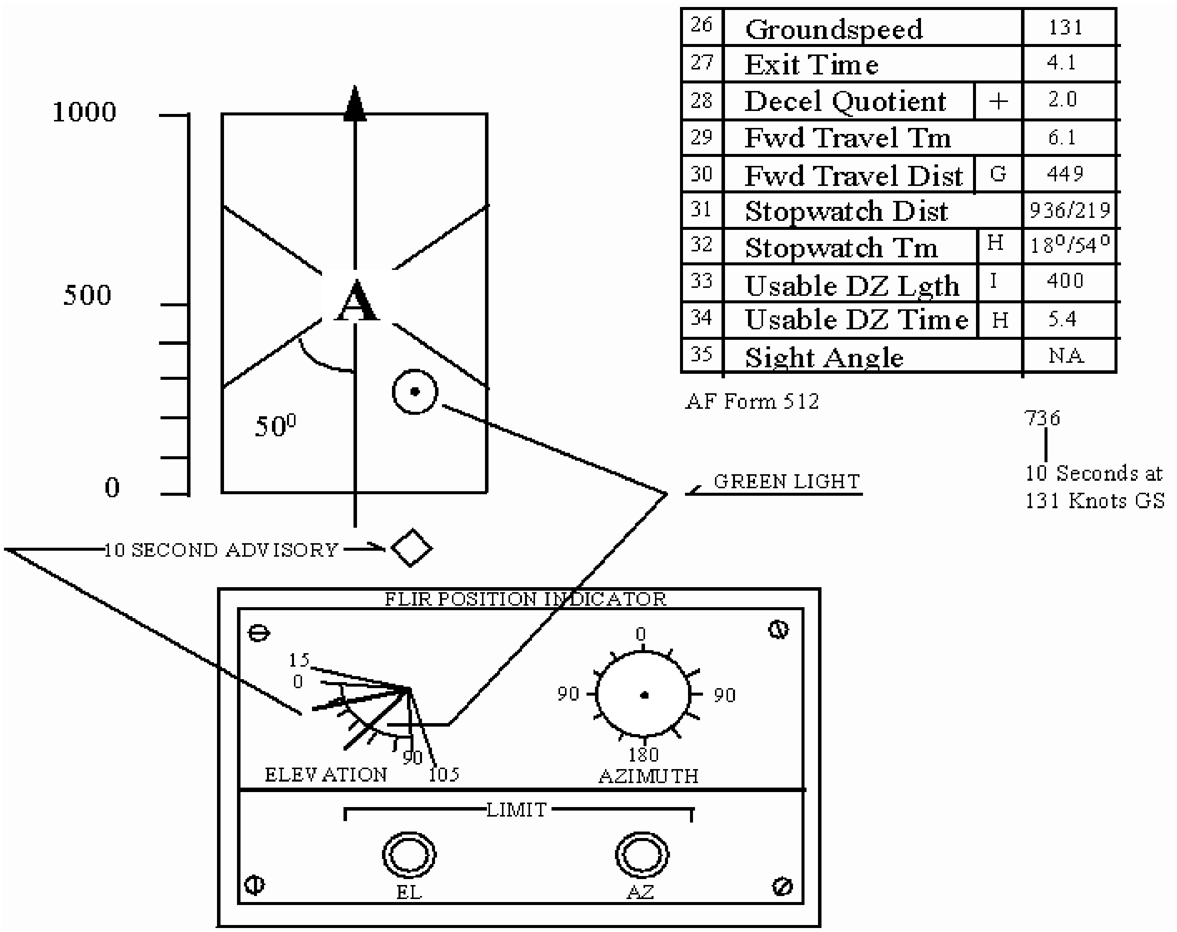
WARNING: The MC-130E FLIR turret is not stabilized for pitch, roll or drift. Elevation and azimuth readings will be accurate only during straight and level flight. Track angle error must be applied to turret azimuth when checking DZ alignment. If the aircraft pitch angle at release can be determined during mission planning, the aircraft pitch angle should be added algebraically to the planned depression angle.

Example: If aircraft pitch angle is 7 degrees nose up, and the depression angle from **Figure 6.4.** is 18 degrees, then the corrected depression angle is 25 degrees. After the slowdown or three minute warning, the left navigator plots the CARP and 10 second warning location (if it falls on the DZ diagram) using the best available wind information. The navigator acquires the line-up target(s) on FLIR and provides the pilot with headings to the CARP.

6.5.3.1. Depression Angle or Azimuth Method. The navigator obtains either the depression angle or relative bearing for the warning location and CARP and records these values on the AF Form 4018. Using a grease pencil, the right navigator marks the face of the FLIR turret position indicator with depression angle and relative bearing for the warning and the CARP, acquires the release target on the FLIR, and maintains it in the center of the FLIR monitor. The navigator monitors the turret position indicators and calls the 10 second warning and the release when the indicators pass the respective elevation or azimuth marks (**Figure 6.6.** and **Figure 6.7.**).

6.5.3.2. Timing Method. The navigator calculates the distance from abeam the target to the 10 second warning location or CARP, recalculates the timing point time based on in-flight groundspeed, and records these values on the AF Form 4018. The right navigator acquires the target on the FLIR and maintains it in the center of the FLIR monitor. The navigator monitors the turret position indicator, begins timing abeam the timing target, and calls the 10 second warning and release based upon stopwatch timing.

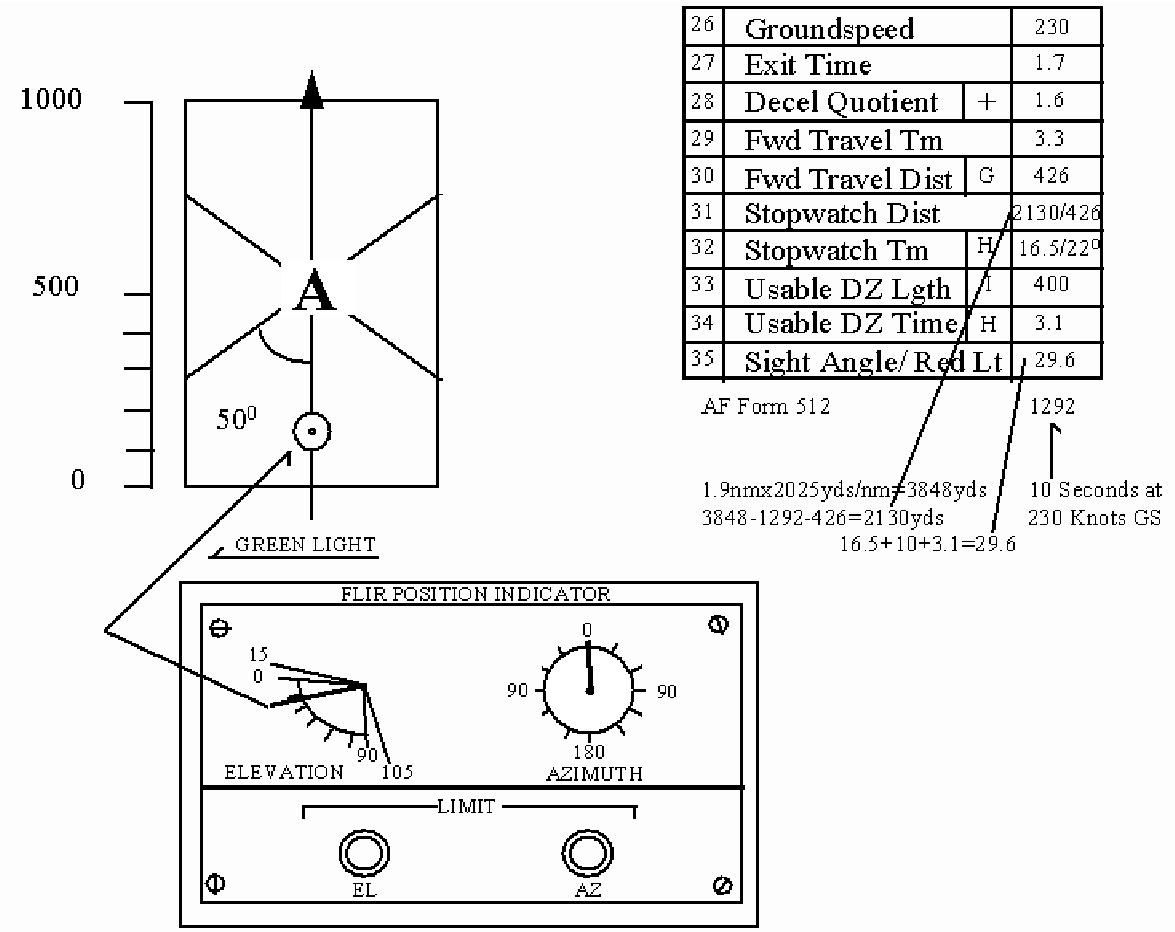
Figure 6.6. FLIR Airdrop (Depression Method).



26	Groundspeed		131
27	Exit Time		4.1
28	Decel Quotient	+	2.0
29	Fwd Travel Tm		6.1
30	Fwd Travel Dist	G	449
31	Stopwatch Dist		936/219
32	Stopwatch Tm	H	18°/54°
33	Usable DZ Lgth	I	400
34	Usable DZ Time	H	5.4
35	Sight Angle		NA

Release Target: PI
Type Drop: Heavy Equipment (G-11A)
Drop Alt: 900 feet AGL
Ballistic W/V: 190/17
CARP Location: 100 yards right
195 yards short
10 second advisory: Depression angle=18°
Release: Depression Angle=54°

Figure 6.7. FLIR Airdrop (Azimuth Method).



Release Target: PI

Type Drop: SATB

Drop Alt: 800 feet AGL

Ballistic W/V: 140/13

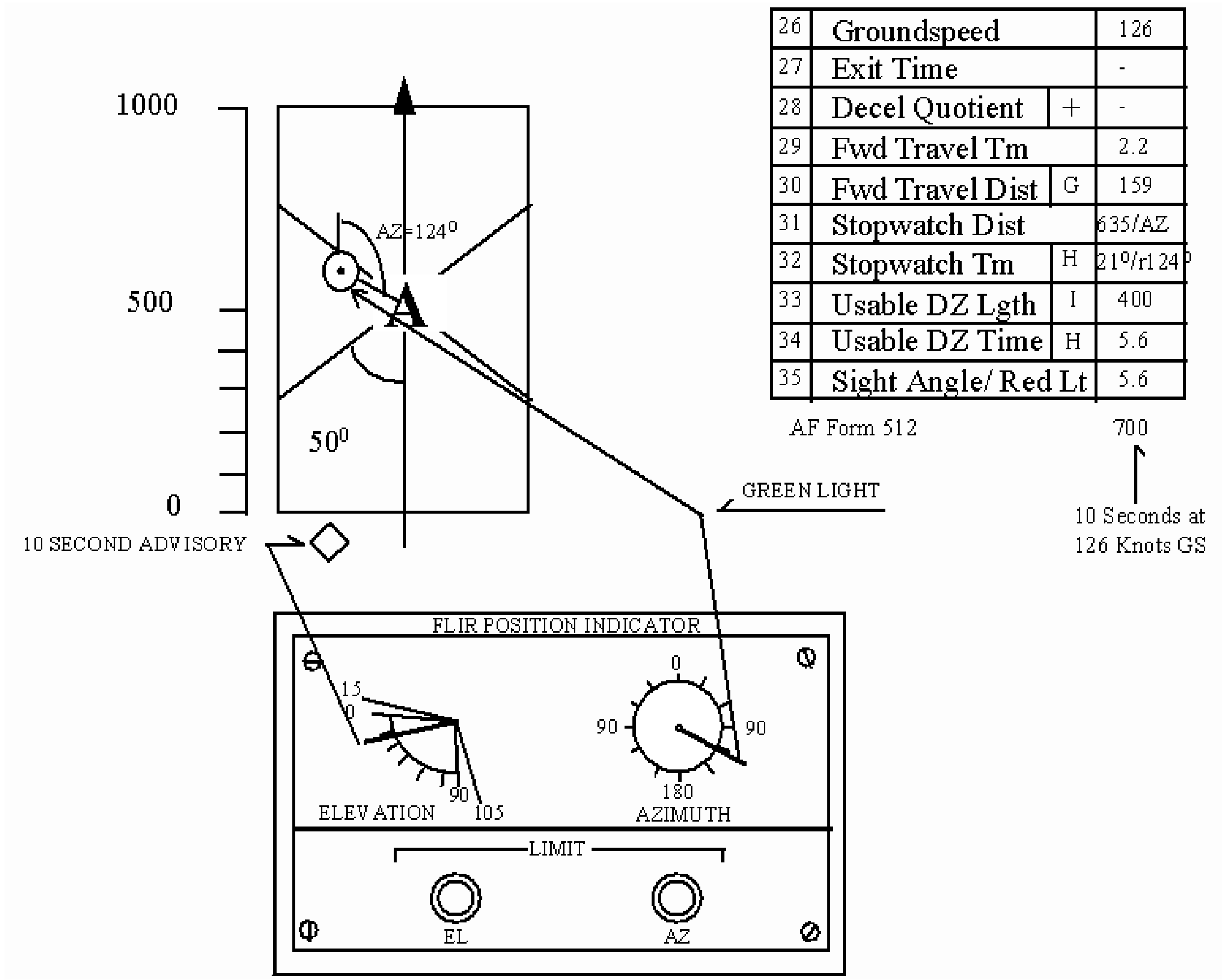
CARP Location: 125 yards left

90 yards short

10 second advisory: Depression angle=21°

Release: Depression Angle=124°

Figure 6.8. FLIR Airdrop (Timing Method).



Release Target: PI
Type Drop: HSLLADS (22’ Ring Slot)
Drop Alt: 500 feet AGL
Ballistic W/V: L/V
CARP Location: 0 yards right
426 yards short
10 second advisory: Timing 16.5 seconds from target (1.9 nm from PI)
Release: Depression Angle=22°

6.6. HC-130 Rescue Airdrop Procedures.

6.6.1. Introduction. A capability to deliver medical personnel, survival gear, and supplies is important to keeping a survivor on the ground viable until a rescue can be effected. HC-130 aircrews maintain qualification to airdrop personnel and rescue equipment during peacetime and contingencies using a variety of available procedures, depending on the situation.

6.6.2. HC-130 Airdrop Options.

6.6.2.1. Threat Environment. During contingencies, avoiding/minimizing detection and time near the survivor location may be a mission requirement, depending on the location and intensity of the threat relative to the location of the survivor. In an environment where the threat is unknown or when it dictates that a single pass over the survivor is desirable to airdrop pararescue personnel (PJs) and/or equipment, Computed Air Release Point (CARP)/High Altitude Release Point (HARP) procedures will likely be employed

6.6.2.2. Non-Threat/Threat-Suppressed. In situations where multiple passes over a survivor are acceptable, standard rescue airdrop procedures have historically proven to be an effective means to deploy PJs and/or rescue-related equipment to a survivor. A variety of patterns to deploy personnel and/or deliver equipment to the survivor may be flown, depending on wind and sea conditions, terrain, weather, and load to be delivered.

6.6.3. Equipment Delivery Parameters

Rescue equipment may be deployed with MA-1/2 Kits, dropped as para-bundles, or dropped free-fall. Each of these will be discussed. Typical chute types, drop altitudes, and load weight capacities for this equipment are listed below.

Figure 6.9. Rescue Airdrop Data.

TYPE OF DELIVERY	MINIMUM DROP ALTITUDE	WEIGHT CAPACITY
MA-1/2 Kits	300	N/A
Parabundles (G-8)	300	7 - 100 lbs
Parabundles (G-13/G14)	400	200 - 500 lbs
Free-Fall Equipment	150	0 - 500 lbs
T-10C	400	100 - 350
NOTE 1. Deployment airspeed will be 130 KIAS.		
NOTE 2. Flap setting will be 50 percent up to 140,000 pounds aircraft gross weight, 70 percent at or above 140,000 pounds aircraft gross weight.		
NOTE 3. Minimum altitude for night equipment airdrops is 500 AGL/AWL.		

6.6.4. Pararescue Deployment.

6.6.4.1. Altitudes.

6.6.4.1.1. Normal. Altitude for pararescueman deployment is normally 1,500 feet AGL.

6.6.4.1.2. Operational. Minimum operational altitude for pararescue deployment is 800 feet AGL.

6.6.4.1.3. Training. If weather is a factor, training may be conducted at 1000 feet AGL minimum.

6.6.4.2. Airspeeds. The aircraft will be maneuvered at 150 KIAS or below in a racetrack pattern (aircraft may be flown on autopilot). Deployment airspeed is 125 KIAS. Static line deployments at airspeeds above 130 KIAS are prohibited due to parachute limitations.

6.6.4.3. Surface Wind Limits.

6.6.4.3.1. Static Line - 13 knots for land, 22 knots for water, 17 knots for tree penetration jumps.

6.6.4.3.2. HGRP - 17 knots for land, 25 knots for water, 22 knots for tree penetration jumps.

6.6.4.4. Crew Duty Differences From C-130E/H Airdrop Mission.

6.6.4.4.1. Spotting Device Requirements. Spotter chute/streamer deployments prior to PJ-directed airdrops are required. Spotting devices may be either chute or streamer. The spotter chute used by USAF pararescuemen is the standard J-1 (12 foot diameter) wind-drift determination parachute. The spotter chute weight can be one provided by the PJ or a MK 6 MOD 3 smoke. Streamers are 20 foot lengths of crepe paper weighted on one end with a 3/4 to 1 ounce metal rod.

6.6.4.5. Fixed Target Pattern.

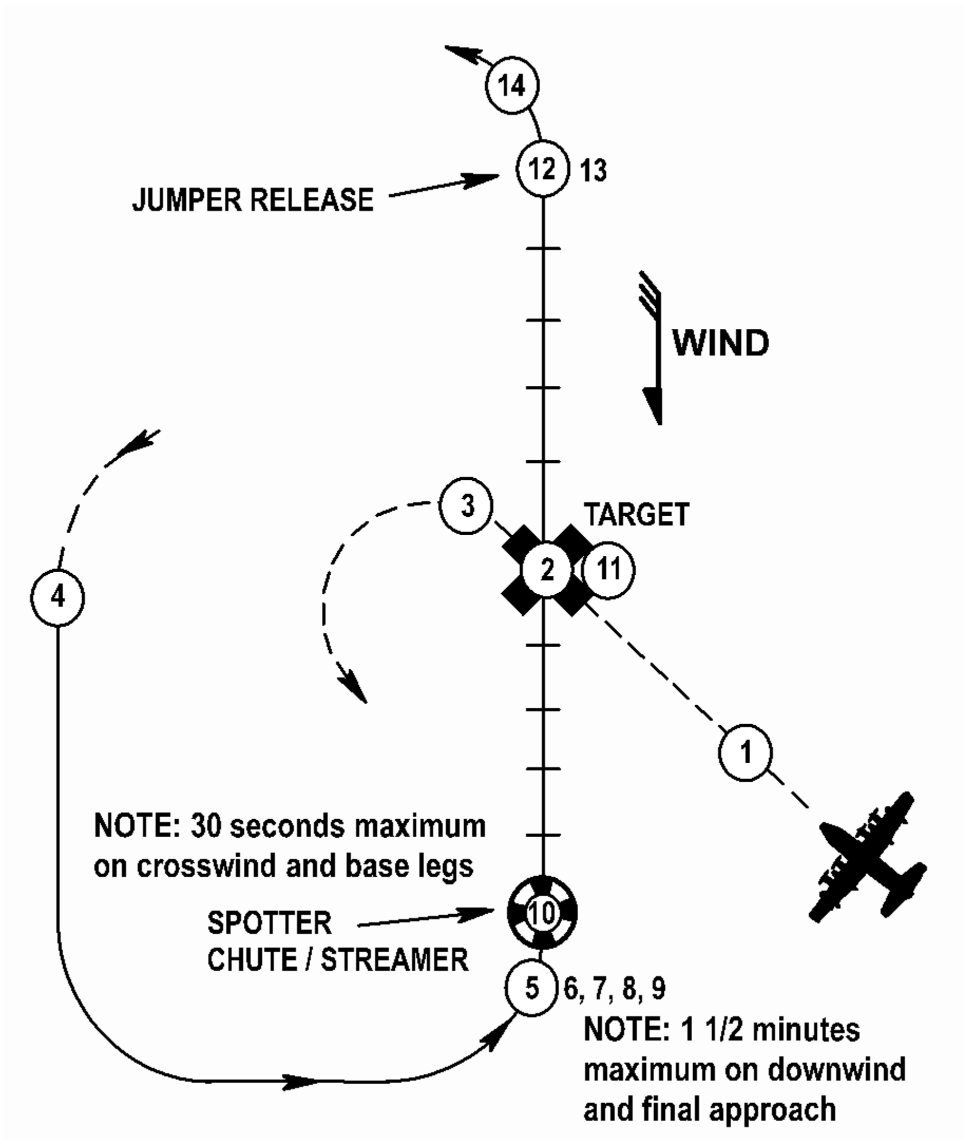
In most cases, PJs will deploy to a stationary (fixed) target. The normal flight pattern will be a racetrack pattern, with the final approach extending from the spotting device to the target. The pattern must be large enough to allow for heading corrections on final approach. Normally, the downwind leg will not exceed one and a half minutes. The crosswind leg will be made as soon as possible after the spotting device or jumper clears the aircraft. It is important that the target area remains in sight at all times.

6.6.4.6. Target is stationary.

Pattern is aligned so that final course extends into the direction of the wind.

6.6.4.7. Fixed Target Pattern Procedures.

Figure 6.10. Fixed Target Pattern.



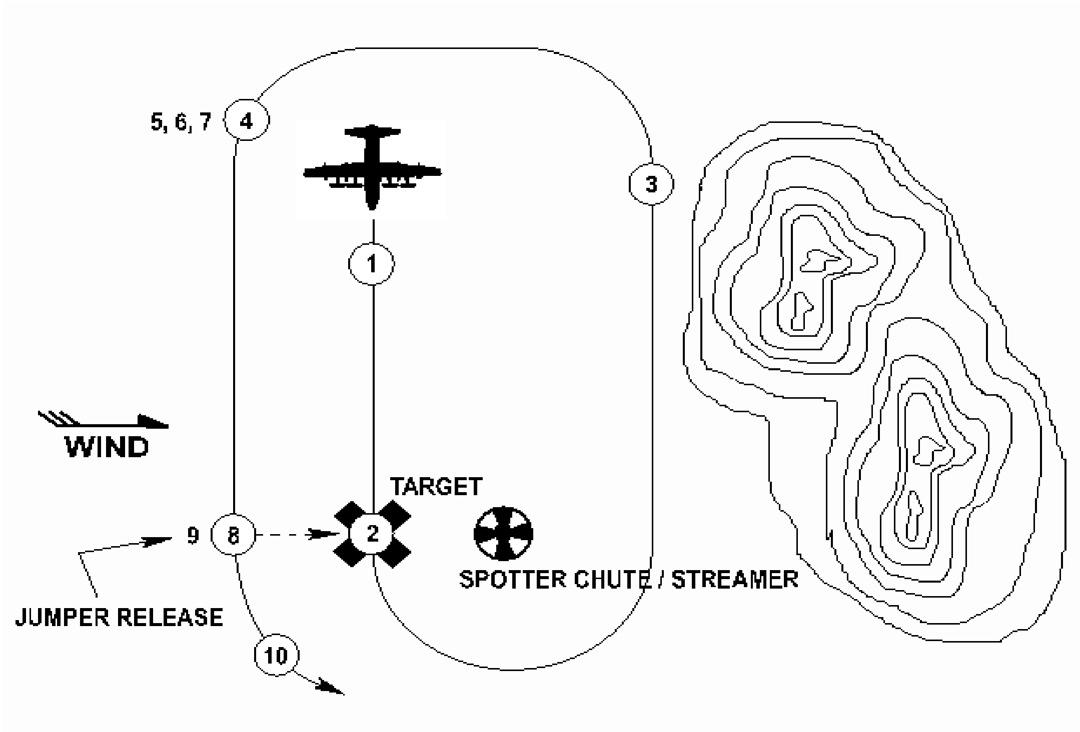
6.6.5. Crosswind Pattern.

6.6.5.1. A crosswind pattern may be required when crews are unable to align the pattern in the direction of the wind. Possible reasons for this include:

No-fly/free-fire zones, terrain, position of the sun or reflection off the surface.

6.6.5.2. Crosswind Pattern Procedures.

Figure 6.11. Crosswind Pattern.

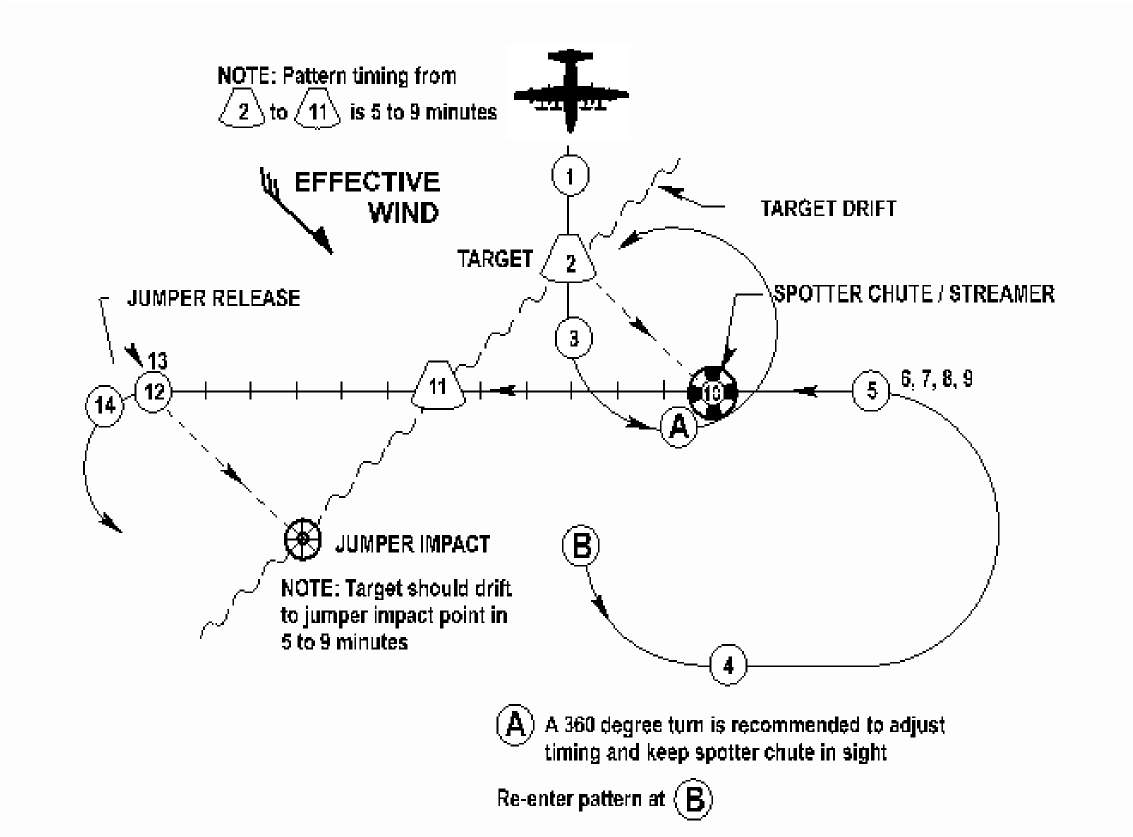


6.6.6. Moving Target Pattern.

6.6.6.1. The Moving Target procedure takes target drift into consideration and will place the pararescueman on the downdrift line of the moving target and not necessarily on target.

6.6.6.2. Moving Target Procedures.

Figure 6.12. Moving Target Pattern.



6.6.7. Post-Deployment.

6.6.7.1. Situation permitting, the aircrew will maintain visual or radio contact with the pararescue team and maintain surveillance of the area for possible hazards. Every effort will be expended to ensure that the pararescue team is covered by rescue aircraft until the party is assured of surface assistance. However, surface assistance for land operation is not required as long as sufficient supplies are available. Prior to departure of the aircraft from the area, resupply schedules, communication schedules, supply requirements, and planned actions of the pararescue team will be established by the aircraft commander and PJ team leader.

6.7. Tri-wall Aerial Distribution System (TRIADS).

6.7.1. A procedure developed to airdrop containers of Meals Ready to Eat (MRE) during humanitarian airdrop operations. This procedure was tested and validated by the US Air Force Mobility Center (USAFMC) in December 1993. The results of this test were printed in AMC Test Plan 1-66-94.

NOTE: This procedure requires MAJCOM approval prior to operation.

6.7.2. This operation uses standard aircrew CDS procedures with slight modifications.

6.7.2.1. Ballistics during testing were:

6.7.2.1.1. Rate of Fall (RF) - 50.0 feet per second

6.7.2.1.2. Vertical Distance (VD) - 0 feet

6.7.2.1.3. Time of Fall Constant (TFC) - 0 seconds

6.7.2.1.4. Forward Travel Time (FTT) - 3.32 seconds

6.7.2.2. Test Director Recommended Ballistics.

6.7.2.2.1. Use AFI 11-231, **Computed Air Release Point Procedures,** ballistic data for HVCDS container weighing 800 pounds with one 26-foot ring slot parachute. Adjust the DQ by adding 3 seconds, and use the standard CDS exit times for CDS per the AFI.

Chapter 7

LEAFLET RELEASE COMPUTATIONS

7.1. General. The airdrop of leaflets in support of psychological warfare operations (PSYOPS) requires the solution of wind drift and dispersion problems measured in nautical miles rather than yards. These solutions are based on average leaflet characteristics and fundamental dead reckoning principles, complicated by the extremely long falling time from even relatively low drop altitudes. The following discussion covers the procedures for computing the best track, altitude and release point for leaflet drops.

7.2. Mission Planning. Leaflet versus CARP Theory. Leaflets move horizontally with the air mass until they reach ground level, offering little or no air resistance. Each type of leaflet has a characteristic rate of fall that can be used along with the ballistic wind vector to determine the release point for a given target center. Unlike parachute supported loads, however, leaflets have no forward travel vector. They do have an additional ballistic, called the spread factor that determines the size of the leaflet pattern when it hits the ground. This factor, combined with the size of the target and the wind speed, determines the drop altitude for low altitude drops. The size and shape of the target, combined with the ballistic wind direction, determines the release track of the aircraft. Leaflet operations are far more affected by in-flight conditions than CARP aerial delivery, since the actual ballistic wind affects not only the release location, but the inbound track, and for low altitude drops, the release altitude. Because of this, an accurate weather forecast is the single most important requirement for a successful leaflet mission.

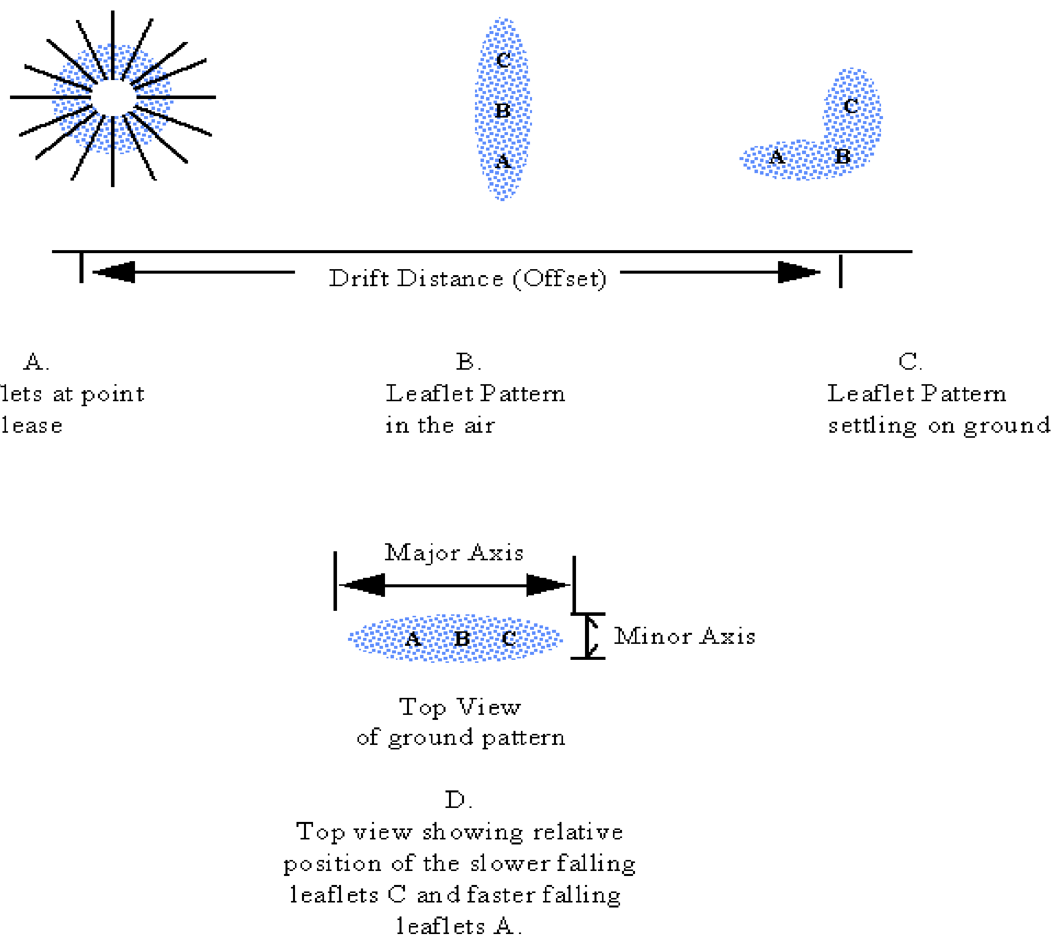
7.2.1. Rate of Fall (V). Leaflets are affected by up-drafts and down-drafts after their release, but overall they will fall at fairly constant rate of a few feet per second. The actual rate of descent (V) varies with altitude due to the change in air density, but for low altitude drops, the rate is essentially equal to the constant sea level rate of fall (V_o). Average wind speed and rate of fall can be used to calculate the horizontal drift distance for the leaflets from their release point until ground contact.

7.2.2. Spread Factor (R_tT_o). If the air was stable and all leaflets fell at exactly the same rate, they would drift with the wind in a tightly packed group to land on one spot. Instead, there is a predictable variation in the descent rates of the individual leaflets. For a given size and weight leaflet, the coefficient of variation, called RtTo or spread factor, is the ratio of the range of descent times for 90% of the leaflets to the average descent time. The larger this value, for a given drift distance, the more the leaflets will spread apart. In addition, the leaflets will spread a small amount, even in still air. The spread factor is independent of the total number of leaflets in the release, so that releasing a larger number of leaflets affects only the density of leaflets on the ground, and not the size of the ground pattern.

7.2.3. Target Coverage Planning:

7.2.3.1. Ground Pattern Size. The ground pattern from a single point release is elliptical in shape due to the variation in descent rates (**Figure 7.1.**). Drift distance is measured along the ballistic wind direction to the center of the major axis, which is also parallel to the ballistic wind. In addition to the spread from still air dispersion, this axis is lengthened by a factor equal to R_tT_o times the drift distance. At low altitude, the length of the minor axis (width of the ground pattern) is due only to still air dispersion and is approximately equal to one-half the drop altitude - about 0.5 nm for a drop altitude of 6,000 feet. Because of the small size of the minor axis, a single point release will be adequate only for narrow targets such as lines of communication and coastlines.

Figure 7.1. Sequence of Events in a Leaflet release.



7.2.3.2. Multiple Release Planning. A continuous release hopper may be used if available, otherwise a series of bundles or delayed-opening packages may be dropped to cover the entire area. The area covered will always be a parallelogram, with two sides parallel to the ballistic wind direction and two parallel to the aircraft track, **Figure 7.2.** The mission planner must determine the optimum parallelogram to cover the target with a minimum of spillover. To determine the required ground pattern, start by drawing two lines parallel to the average wind direction at each end of the target, **Figure 7.3.**A. These form the extreme pattern start and end points. Pick the track axis by drawing two parallel lines to en-close the target area but as little of the outside area as possible, **Figure 7.3.**B. Finally, if excessive numbers of leaflets will be wasted in order to include a small portion of the target area, the mission planner may elect to reduce the size of the selected parallelogram to optimize expended leaflets, **Figure 7.3.**C. The distance along the track axis (from point A to B in **Figure 7.3.**C) is the target length, and is used to determine the number of releases. The distance along the wind axis (from point C to D) is the major axis length, and is used to determine the drop altitude.

Figure 7.2. Multiple Bundle Release.

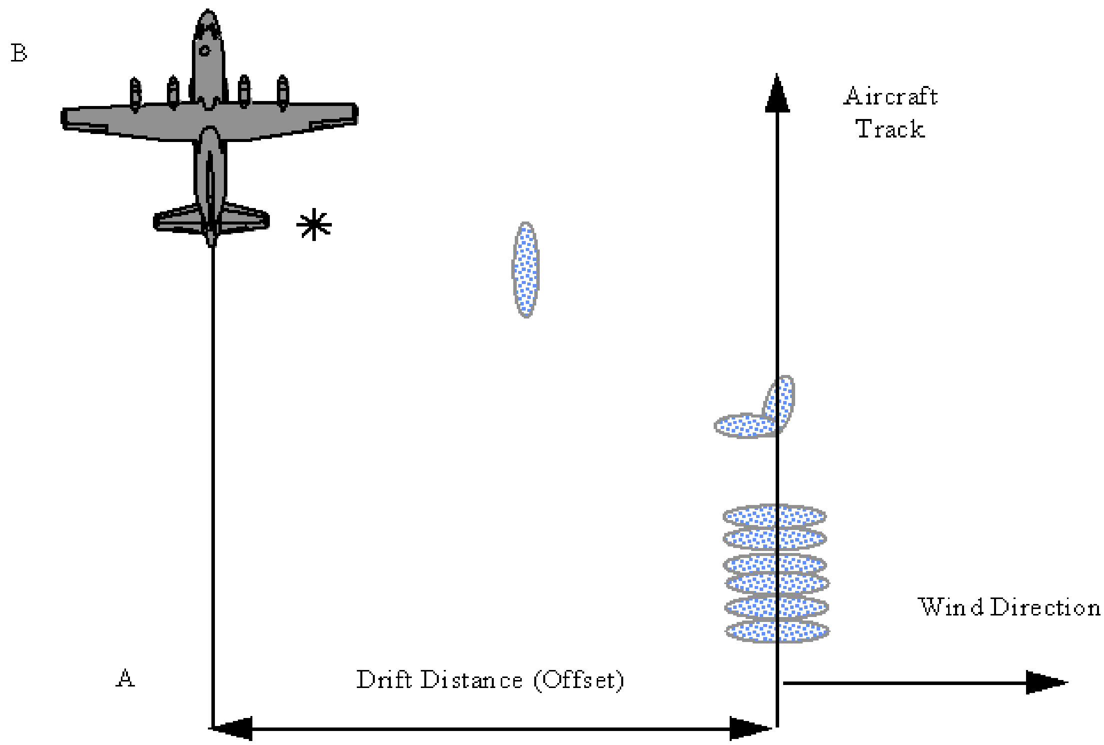
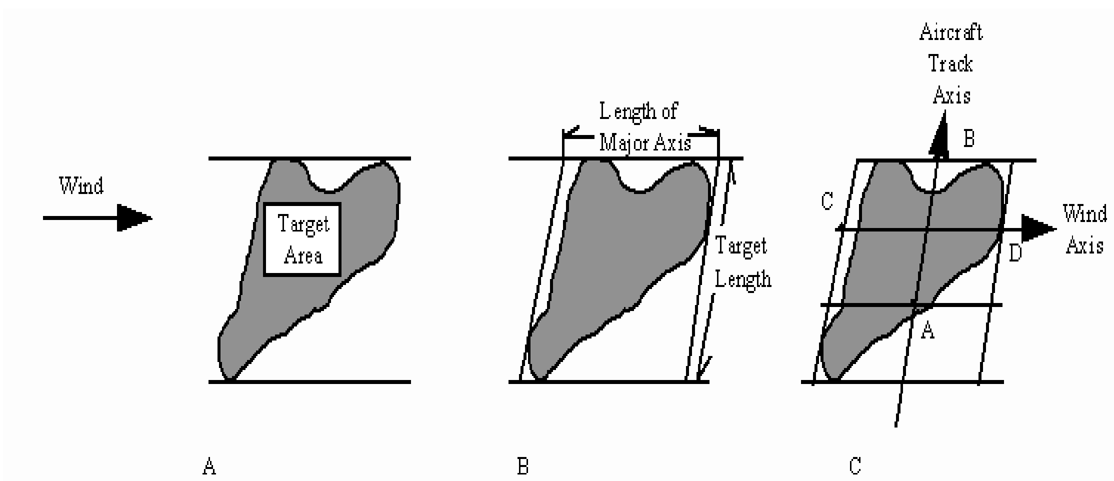


Figure 7.3. Determination of Major Axis and Target Length.



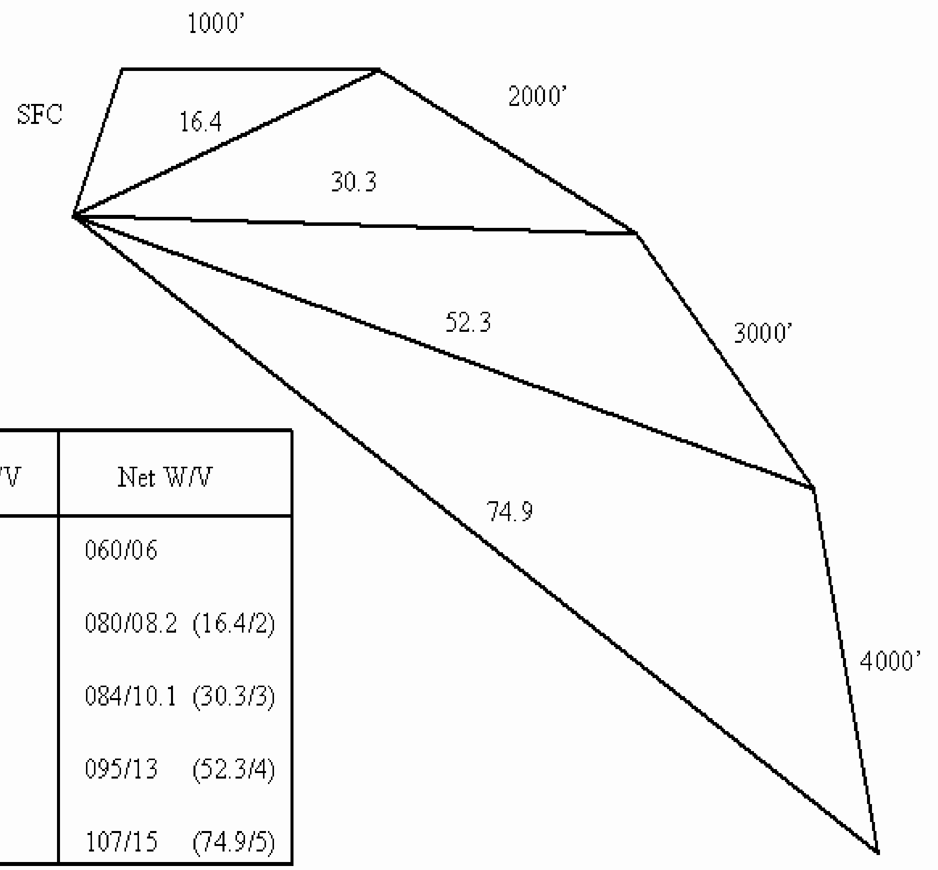
7.2.4. Low versus High Altitude Releases. High altitude leaflet drops permit a larger target area to be covered for a given number of leaflets. High level wind patterns, however, may place the release point inside denied airspace or expose the aircraft and crew to threats. A low altitude release may also be preferable if the target area is small, the number of leaflets is limited, or spillover into adjacent territory must be avoided. In general, targets five miles in diameter or smaller are acceptable for low altitude drops.

7.3. Low Altitude Release Procedures (Method 1).

7.3.1. Winds. For low altitude leaflet drops, the ballistic wind affects the inbound track and the release altitude, as well as the location of the release point. Also, in a threat area, a climb to check winds over the target may not be possible. Mid-altitude winds can be checked en route or during the climb to drop altitude. The computations shown below make it possible to update the release point using winds obtained in the climb, as long as the actual wind direction is fairly close to those used in preflight planning. Changes in wind speed, but not direction, will affect the drop altitude more than the required offset. These changes can be adjusted for after the climb to drop altitude has begun. Changes in the wind direction, on the other hand, are practically impossible to readjust close to the target area. This is because both the track axis and the required major axis length are changed, affecting the drop altitude and the offset distance. For these reasons, an accurate preflight wind is extremely important. After obtaining preflight winds, consider the effect of any terrain in the target area and up to five to ten miles upwind of the target.

7.3.2. Wind Averaging (**Figure 7.4.**). Obtain forecast winds at the surface and at each 1,000 foot increment up to 4,000 feet above target elevation. Using the DR computer wind face or graph paper, determine the net wind direction and velocity from the surface to each 1,000 foot altitude up to 4,000 feet.

Figure 7.4. Wind Averaging Example.



Altitude	Forecast W/V	Net W/V
SFC	060/06	060/06
1000'	090/11	080/08.2 (16.4/2)
2000'	090/14	084/10.1 (30.3/3)
3000'	110/23	095/13 (52.3/4)
4000'	130/26	107/15 (74.9/5)

7.3.3. Instructions for Completing AF Form 4011, **Low Altitude Leaflet Computations**. The net wind velocities from the averaging example above are used in the following example. While wind direction is not used directly in the calculations, the net wind direction at 4,000 feet (107 degrees) is used to determine the required major axis length, **Figure 7.2.** and **Figure 7.3.**

7.3.3.1. Enter the preflight data for the example shown below on AF Form 4011, **Figure 7.5.**
Major axis of target (along net wind dir.): 3.0 nm
Length of target (along desired track): 4.0 nm
Leaflet type: 8.5" X 3.2" / 20# paper

7.3.3.2. If the paper weight is unknown, follow the instructions in the NOTE at the end of **Figure 7.6.** With the leaflet size and paper weight, enter the reverse side of AF Form 4011, Figure 7.6., to find the spread factor (R_tT_o) and ground rate of fall (V_o) (0.43 and 1.7 ft/sec in the example). Enter these values in block 11, and enter the spread factor in the "1 nm drift distance" block on the graph as well. This value corresponds to 1 nm of drift distance. Mark the horizontal scale with a tick mark at the value of R_tT_o. Use dividers (or multiply RtTo by 2, 3, 4, ...) to mark tick marks at equal intervals along the rest of the horizontal scale. Label mark in intervals of 1 nm drift distance, **Figure 7.5.**

7.3.3.3. Calculate $(R_tT_o)/V_o$ and enter the result in the "1 knot Wind Velocity" block on the graph (0.253 in the example). This value corresponds to 1 knot of wind velocity. As with the drift distance, mark the vertical scale in intervals of 1 knot. Label the marks in intervals of 1 or 5 knots, as desired.

NOTE: Steps (1) and (2) above need not be repeated for each mission if the leaflet size and weight remains unchanged. The graph with marked and labeled scales may be reproduced and reused.

7.3.3.4. Mark the forecast surface wind on the vertical wind scale. Using the preflight net wind velocities calculated in paragraph (2) above, plot each net wind on each slanted altitude line, **Figure 7.5.** If necessary, obtain wind forecasts for higher altitudes and calculate additional net winds to extend the wind line as close as possible to the right side of the chart.

7.3.3.5. Mark a point (P on **Figure 7.5.**) at the intersection of the wind line and the curved vertical line corresponding to the required major axis, interpolating as necessary. Project from point P vertically down to find the required offset distance upwind from the target track axis (6.4 nm in the example). Interpolate point P between the slanted altitude lines to find the required drop altitude (3000 feet in the example). Enter the Drift Distance and Drop Altitude in blocks 1 and 16 respectively.

7.3.3.6. AF Form 4011 Completion Requirements:

7.3.3.6.1. Item 1 - Drop Altitude: The absolute altitude above the target (determined from graph).

7.3.3.6.2. Item 2 - Target Elevation: Mean elevation of the target area.

7.3.3.6.3. Item 3 - True Altitude: The drop altitude, in feet, above mean sea level (Item 1 plus Item 2).

7.3.3.6.4. Item 4 - Pressure Altitude Variation (PAV): The difference in feet between mean sea level and the standard datum plane. Compute using formula A and the forecast target altimeter setting, converting 0.01 inches of mercury to 10 feet of altitude.

7.3.3.6.5. Item 5 - Pressure Altitude: Drop altitude, in feet, above the standard datum plane (Item 3 plus Item 4).

7.3.3.6.6. Item 6 - True Altitude Temperature: Temperature in degrees Celsius at the drop altitude.

7.3.3.6.7. Item 7 - Indicated Altitude: The altitude to be flown with the target altimeter setting in the barometric scale or Kollsman window of the aircraft's pressure altimeter. Compute using formula B and the ALTITUDE COMPUTATIONS window of the DR computer.

7.3.3.6.8. Item 8. IAS/CAS/TAS: Indicated/ Calibrated/True Airspeeds as specified by aircrew operational procedures, manuals, and directives. CAS equals IAS corrected for pitot-static error, aircraft attitude, and instrument error. EAS equals CAS corrected for compressibility. Use a drop IAS between 180 and 200 KIAS. Airspeeds above 200 KIAS are not recommended because leaflets may blow back into the cargo compartment. True airspeed is computed on the DR computer using the AIRSPEED COMPUTATIONS window and the formula:

$$\frac{\text{Temperature}}{\text{Pressure Altitude}} = \frac{\text{(TAS)}}{\text{EAS}}$$

7.3.3.6.9. Item 9 - Major Axis/Target Length: The target major axis and length as measured from the chart.

7.3.3.6.10. Item 10 - Paper Size/Weight: Size and weight of leaflets to be dropped. If weight is unknown, follow directions in NOTE on back of AF Form 4011.

7.3.3.6.11. Item 11 - R_tOT_o,V_o: Spread factor and sea level rate of fall for the specified leaflet. Obtained from tables on back of AF Form 4011.

7.3.3.6.12. Item 12 - Minor Axis: Width in nm of the ground pattern of each individual bundle. Always less than 1.0 nm for low altitude drops (approximately 0.08 nm per 1000 feet of drop altitude). Compute using formula C. Not required for continuous (hopper) release operations.

7.3.3.6.13. Item 13 - Navigator: Self-explanatory.

7.3.3.6.14. Item 14 - Target Area: Geographic description, coordinates, or radial/DME of target area.

7.3.3.6.15. Item 15 - Start Climb Point: Distance in nm at which the aircraft must leave low level to arrive at drop altitude in time for the first release. Calculate using rate of climb at 180 KIAS (may be approximated) and the difference between drop altitude and low level en route altitude.

7.3.3.6.16. Item 16 - Drift Distance (Offset): Drift distance, in nm, the leaflets will descend when dropped from altitude. Obtained from graph.

7.3.3.6.17. Item 17 - Drop Altitude Wind: The forecast or in-flight magnetic wind which determines the aircraft magnetic heading at release.

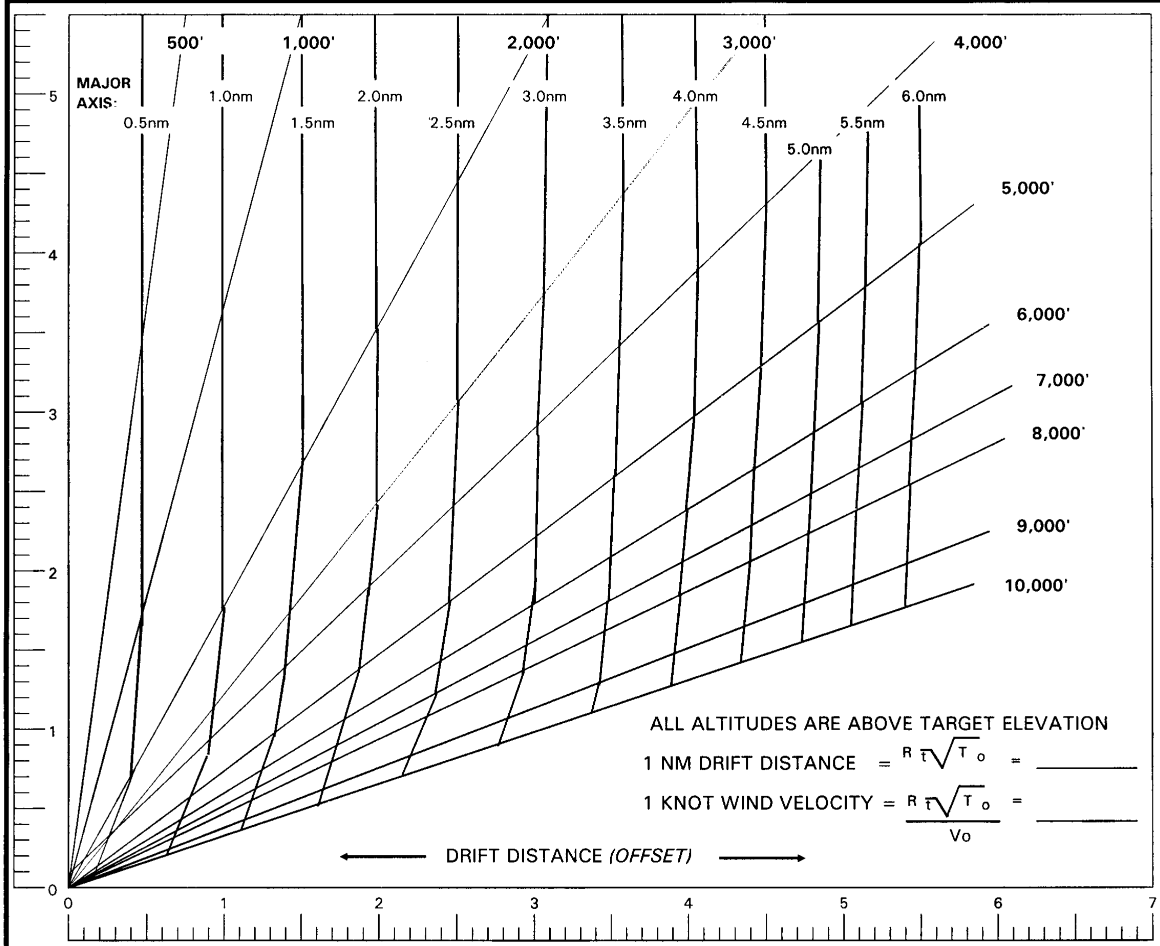
7.3.3.6.18. Item 18 - Mag Course: The track axis selected for the target.

7.3.3.6.19. Item 19 - Drift Correction: Computed on the DR computer using drop altitude wind, TAS and magnetic course.

7.3.3.6.20. Item 20 - Mag Heading: The heading to be flown at release (Item 18 + Item 19).

Figure 7.5. Low Altitude Leaflet Computation Sample (AF Form 4011).

LOW ALTITUDE LEAFLET COMPUTATIONS



NOTE: FOR PAPER WEIGHTS SEE REVERSE AND PRINT IN LANDSCAPE

1	DROP ALTITUDE			9	MAJOR AXIS TGT LENGTH	13	NAVIGATOR		
2	TARGET ELEVATION	+		10	PAPER SIZE/WEIGHT	14	TARGET AREA		
3	TRUE ALTITUDE			11	R t √T o = Vo =	15	START CLIMB POINT		
4	PAV	+ A		12	*MINOR AXIS (< 1 NM)* C O NM	16	DRIFT DIST *(OFFSET)*		
5	PRESSURE ALTITUDE			C	DROP ALTITUDE / ▲ = *(MINOR AXIS-NM)* / .495	17	DROP ALT W/V		
6	TRUE AIR TEMP					18	MAG COURSE		
7	INDICATED ALTITUDE	B		D	GROUND SPEED / ▲ *(3600)* = TARGET LENGTH-NM / *(TOTAL TIME)*	19	DRIFT CORRECTION		
8	IAS/CAS/TAS					20	MAG HEADING		
A	29.92 / ( ) + = ( ) / 29.92 -			E	TARGET LENGTH / MINOR AXIS = *(# OF RELEASES)* / 1.0	21	GROUND SPEED		
						22	TOTAL TIME AT ALT.	D	
B	*(ALTITUDE WINDOW)* TEMPERATURE / PRESSURE ALT = TRUE ALTITUDE / *(INDICATED ALT)*			F	TOTAL TIME / # OF RELEASES = *(RELEASE INTERVAL)* / 1.0	23	# OF RELEASES	E	
						24	RELEASE INTERVAL	F	

AF FORM 4011, JUN 98 (LRA-V1) REPLACES AFSOC FORM 2, JUL 89, WHICH IS OBSOLETE. PAGE 1 OF 2 PAGES

Figure 7.6. Reverse Side of (AF Form 4011).

PAPER WEIGHT PAPER SIZE (IN)	9 LB VO RT/TO	13 LB VO RT/TO	16 LB VO RT/TO	20 LB VO RT/TO	60 LB VO RT/VO
22 X 17.00				3.7 0.46	3.5 0.36
13 X 6.00					5.0 0.37
11 X 11.00	2.5 0.37	3.1 0.36	3.3 0.31	2.9 0.24	
X 8.80	2.6 0.32	2.6 0.22	2.8 0.21	3.2 0.23	
X 7.33	2.6 0.25	2.8 0.24	3.0 0.29	3.3 0.42	
X 6.29	2.5 0.16	2.7 0.40	2.7 0.23	3.7 0.78	
X 5.50	2.9 0.18	3.0 0.34	4.5 0.20	5.0 0.58	
X 4.40	2.8 0.21	3.5 0.26	4.1 0.30	5.8 0.61	
X 4.00	2.8 0.12	3.6 0.19	3.9 0.25	5.9 0.62	
X 3.67	2.8 0.12	3.0 0.33	4.0 0.46	3.5 0.78	
X 3.38	2.6 0.19	2.9 0.34	*2.8 0.18	*2.0 0.57	
X 2.75	2.5 0.18	2.1 0.56	*1.7 0.49	*1.8 0.41	
10-1/2 X 10.50			3.1 0.33		
X 8.00			2.9 0.24		4.2 0.55
X 5.33			3.5 0.20		
X 4.00			3.5 0.23		
X 3.20			2.7 0.33		
10-3/8 X 4.00				4.4 0.40	
X 3-3/16			3.0 0.30		*2.2 0.47
X 2-9/16			*2.3 0.29	*2.5 0.38	
10 X 8.00				3.4 0.31	3.3 0.35
X 7.76					3.0 0.29
X 6.00					4.0 0.44
X 5.00					4.2 0.44
X 3.20				*2.1 0.41	
9-1/4 X 3.75					2.6 0.73
9 X 3.70					*2.8 0.73
X 3.50			3.4 0.27		
X 3.00			*2.1 0.45		
8-3/4 X 3.50			3.3 0.45		
8-1/2 X 8.50	2.9 0.24	2.5 0.31	2.7 0.26	2.8 0.35	
X 6.39	2.1 0.22	2.2 0.24	2.6 0.30	2.8 0.15	
X 5.67	2.2 0.42	3.0 0.31	3.2 0.27	4.0 0.58	
X 4.86	2.4 0.37	2.8 0.26	3.4 0.69	3.7 0.63	
X 4.25	2.7 0.20	3.4 0.25	3.8 0.68	5.2 0.71	
X 3.60			3.5 0.38		
X 3.40	3.0 0.16	3.4 0.36	4.4 0.69	4.0 1.01	
X 3.20				*1.7 0.43	*1.6 0.31
X 3.09	3.0 0.15	3.2 0.27	3.6 0.65	*1.9 0.42	
X 3.00			*2.3 0.41		*1.6 0.42
X 2.83	2.0 0.34	2.3 0.36	*1.8 0.91	*2.2 0.23	*2.0 0.34
X 2.75					*2.5 0.31
X 2.62	2.9 0.24	2.9 0.60	*2.2 0.50	*2.2 0.27	
X 2.13	*1.7 0.80	*2.0 0.36	*1.8 0.30	*2.2 0.40	
8-1/4 X 3.50			3.9 0.48		
X 3.38					*2.2 0.71
8-1/16 X3-9/16					*2.1 0.73
8 X 5.25			3.3 0.33	3.8 0.36	4.3 0.49
X 3.50			4.9 0.45		*2.4 0.44
X 3.00			2.4 0.51		
X 2-7/8			*2.1 0.51		
X 2-3/4			*2.4 0.65		
X 2-5/8			*1.5 0.18		
X 2.50			*2.2 0.36		

PAPER WEIGHT PAPER SIZE (IN)	9 LB VO RT/TO	13 LB VO RT/TO	16 LB VO RT/TO	20 LB VO RT/TO	60 LB VO RT/VO
7-3/4 x 3.50			3.6 0.51		
7-1/2 x 3.50			3.8 0.51		
x 3.09				*1.9 0.48	
x 3.00				*1.8 0.51	
7 x 5.00				2.9 0.27	
x 4.00			3.4 0.40		
x 3.50			3.3 0.35		
x 3.00			3.0 0.52		
6-1/2 x 5.00			3.0 0.38	3.1 0.30	
6-1/4 x 3.50			3.3 0.35		
6 x 6.00	2.4 0.33	2.3 0.44	2.7 0.32	2.7 0.26	
x 4.80	2.2 0.56	2.4 0.23	2.8 0.20	3.0 0.13	
x 4.00	2.3 0.26	2.7 0.37	3.3 0.63	4.0 0.46	
x 3.43	2.6 0.51	2.9 0.55	4.5 0.95	4.7 1.00	
x 3.00	3.1 0.48	3.6 0.89	4.7 1.04	*2.5 1.11	*1.8 0.54
x 2.40	2.5 0.34	2.4 0.87	*1.4 0.28	*1.5 0.23	
x 2.18	2.6 0.49	*1.5 0.52	*1.4 0.26	*1.6 0.21	
x 2.00	*2.3 0.67	*1.3 0.59	*1.6 0.36	*1.7 0.22	
x 1.85	*2.2 0.56	*1.5 0.27	*1.9 0.24	*1.8 0.30	
x 1.50	*1.8 0.30	*1.5 0.09	*2.1 0.17	*2.1 0.22	
5-27/32x2-7/16				*1.5 0.14	
5-5/8 x 5.25					2.6 0.21
x 2.75			3.3 0.30	*2.6 0.50	*2.4 0.43
5-1/2 x 4.00			3.1 0.34		
5-5/16x5-5/16				3.1 0.34	
x 4.25					3.2 0.33
x 4-1/8					3.2 0.31
x3-13/16					3.4 0.27
x 2-9/16			2.5 0.51	*1.7 0.36	
5-1/4 x 3.20			3.0 0.20		
x 3.00			2.6 0.34	2.4 0.38	
5-3/16 x4-1/16					2.9 0.23
x 4.00				3.1 0.31	3.0 0.18
4-1/2 x 4.00				2.9 0.26	
4 x 4.00	2.0 0.31	2.2 0.12	2.4 0.20	2.6 0.19	
x 3.20	2.2 0.18	2.4 0.12	2.6 0.11	3.0 0.16	
x 2.67	2.2 0.30	2.6 0.13	2.8 0.20	3.1 0.16	
x 2.29	2.2 0.14	2.6 0.14	*2.3 0.32	*2.1 0.52	
x 2.00	2.1 0.13	*1.8 0.27	*1.5 0.05	*1.7 0.05	
x 1.60	*1.3 0.56	*1.3 0.16	*1.4 0.23	*1.7 0.05	
x 1.45	*1.0 0.45	*1.3 0.34	*1.5 0.42	*1.7 0.07	
x 1.33	*1.3 0.33	*1.3 0.25	*1.5 0.23	*1.7 0.12	
x 1.23	*1.3 0.24	*1.5 0.34	*1.6 0.28	*1.6 0.65	
x 1.00	*1.3 0.18	*1.6 0.50	*1.9 0.63	*2.1 0.54	

NOTE: IF PAPER WIEGHT IS UNKNOWN, MEASURE ONE POUND OF LEAFLETS, MULTIPLY THE AREA (LENGTH X WIDTH) OF ONE LEAFLET BY THE NUMBER OF LEAFLETS IN ONE POUND, CHOOSE THE PAPER WEIGHT LISTED BELOW THAT MOST NEARLY EQUALS YOUR ANSWER:

20,778 FOR 9 LB PAPER
11,875 FOR 16 LB PAPER
14,385 FOR 13 LB PAPER
9,350 FOR 20 LB PAPER
7,917 FOR 60 LB PAPER

* ASTERISKS VALUES INDICATE LEAFLET IS AN AUTOROTATOR.

AF FORM 4011, JUN 98 *(LRA-V1)* *(REVERSE)*

PAGE 2 OF 2 PAGES

NOTE: If paper weight is unknown, measure one pound of leaflets, multiply the area (LxW) of one leaflet by the number of leaflets in one pound, choose the paper weight listed below that most nearly equals your answer: 20,778 for 9 lb - 14,385 for 13 lb - 11,875 for 16 lb - 9,350 for 20 lb - 7,917 for 60 lb.

Underlined values indicate leaflet is an autorotator.

7.3.3.6.21. Item 21 - Groundspeed: The preflight or actual groundspeed calculated using the drop altitude wind.

7.3.3.6.22. Item 22 - Total Time at Altitude: Time in seconds from the first release until the end of the release track. Compute using formula D and the seconds index (36) on the DR computer.

7.3.3.6.23. Item 23 - Number of Releases: The number of bundles required for a multiple release. Compute using formula E. Not required for continuous release operations.

7.3.3.6.24. Item 24 - Release Interval: Time in seconds between successive bundles for multiple drops. Compute using formula F. Not required for continuous release operations.

7.3.4. In-flight Procedures. Refer to employment volumes for specific aircraft for in-flight aircrew procedures and tactical checklists.

7.4. Low Altitude Release Procedures (Method 2):

7.4.1. Figures 7.7 to 7.12 contain 19 descent rates (V_0) that apply to many leaflets of various sizes and paper weights. Once the descent rate has been determined for a given leaflet, the drift distance to the center of the leaflet pattern or mass can be determined. For example, when dropping at 3000 feet the (V_0) for the 6”x3” leaflet (20 lb) is 2.5' per second (see Figure 7.6.). For a 10 knot wind, reading across figure **Figure 7.7.** to the 2.5 feet per second column, we find the total drift to the center of impact is 3.8 nm.

7.4.2. The length of the leaflet pattern or major axis can also be determined by multiplying the spread factor (R_TOT_0) found on the reverse side of AF Form 4011 (Figure 7.6.) by the total drift distance. For example, as determined above, center of mass for the 6”x3” leaflet in 20 lb. paper weight drifted 3.8nm in a 10 knot wind. To find the major axis of the leaflet pattern, multiply the spread factor (RTT0) of 1.11 times the drift distance of 3.8 nm and the answer is 4.2 nm. To this add 1/2 of the release altitude which is 1500' or .25nm for a total major axis of 4.45 nm. The minor axis is then computed at 1/2 the release altitude. In this example the minor axis is .25 nm.

7.4.3. If a last minute decision is made to fly at a lower altitude due to high winds or low hanging clouds, an adjustment can be made to account for the change. Using the above example, if the drop is made from 2,000 feet, the drift distance is then 2/3rds of the answer shown or if from 500 feet, 1/6th of the answer shown.

7.4.4. The distance of ground elevation above sea level must also be taken into consideration. The data in figures **Figure 7.7.** to 7.12 are from the specified altitude to sea level. As in the above example, if the target elevation is 500 feet, then the leaflet only falls 2500 feet or 5/6ths of the answer shown.

Figure 7.7. Leaflet Drift Chart - 3000 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.6	.6	.5	.5	.4	.4	.4	.4	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2
2	1.3	1.1	1.0	.9	.8	.8	.8	.7	.7	.6	.6	.6	.5	.5	.4	.4	.4	.4	.4
3	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1.1	1.0	.9	.9	.8	.8	.7	.7	.7	.6	.6	.6
4	2.6	2.2	2.0	1.8	1.7	1.6	1.5	1.5	1.3	1.2	1.1	1.1	1.1	1.0	.9	.9	.8	.8	.8
5	3.2	2.8	2.5	2.3	2.1	2.0	1.9	1.9	1.7	1.5	1.4	1.4	1.4	1.2	1.1	1.1	1.0	1.0	1.0
6	3.8	3.4	2.9	2.7	2.5	2.3	2.3	2.2	2.0	1.7	1.7	1.7	1.6	1.4	1.3	1.3	1.2	1.2	1.2
7	4.5	4.0	3.4	3.2	2.9	2.7	2.7	2.6	2.3	2.0	2.0	2.0	1.9	1.7	1.5	1.5	1.3	1.3	1.3
8	5.1	4.5	3.9	3.6	3.4	3.1	3.0	3.0	2.6	2.3	2.3	2.2	2.2	1.9	1.8	1.8	1.5	1.5	1.5
9	5.8	5.0	4.4	4.1	3.8	3.5	3.4	3.3	3.0	2.6	2.6	2.5	2.4	2.2	2.0	2.0	1.7	1.7	1.7
10	6.4	5.6	4.9	4.5	4.2	3.9	3.8	3.7	3.3	2.9	2.9	2.8	2.7	2.4	2.2	2.2	1.9	1.9	1.9
11	7.0	6.2	5.2	5.0	4.6	4.3	4.2	4.1	3.6	3.2	3.1	3.1	3.0	2.6	2.4	2.4	2.1	2.1	2.1
12	7.7	6.7	5.9	5.4	5.0	4.7	4.6	4.4	4.0	3.5	3.4	3.4	3.2	2.9	2.6	2.6	2.3	2.3	2.3
13	8.3	7.3	6.4	5.9	5.5	5.1	4.9	4.8	4.3	3.8	3.7	3.6	3.5	3.1	2.9	2.9	2.5	2.5	2.5
14	9.0	7.8	6.9	6.3	5.9	5.5	5.3	5.2	4.6	4.1	4.0	3.9	3.8	3.4	3.1	3.1	2.7	2.7	2.7
15	9.6	8.4	7.4	6.8	6.3	5.9	5.7	5.6	5.0	4.4	4.3	4.2	4.1	3.6	3.3	3.3	2.9	2.9	2.9
16	10.2	9.0	7.8	7.2	6.7	6.2	6.1	5.9	5.3	4.6	4.6	4.5	4.3	3.8	3.5	3.5	3.0	3.0	3.0
17	10.9	9.5	8.3	7.7	7.1	6.6	6.5	6.2	5.6	4.9	4.8	4.8	4.6	4.1	3.7	3.7	3.2	3.2	3.2
18	11.5	10.1	8.8	8.1	7.6	7.0	6.8	6.7	5.9	5.2	5.1	5.0	4.9	4.3	4.0	4.0	3.4	3.4	3.4
19	12.2	10.6	9.3	8.6	8.0	7.4	7.2	7.0	6.3	5.5	5.4	5.3	5.1	4.6	4.2	4.2	3.6	3.6	3.6
20	12.8	11.2	9.8	9.0	8.4	7.8	7.6	7.4	6.6	5.8	5.7	5.6	5.4	4.8	4.4	4.4	3.8	3.8	3.8
21	13.4	11.8	10.3	9.5	8.8	8.2	8.0	7.8	6.9	6.1	6.0	5.9	5.7	5.0	4.6	4.6	4.0	4.0	4.0
22	14.1	12.3	10.8	9.9	9.2	8.6	8.4	8.1	7.3	6.4	6.3	6.2	5.9	5.3	4.8	4.8	4.2	4.2	4.2
23	14.7	12.9	11.3	10.4	9.7	9.0	8.7	8.5	7.6	6.7	6.6	6.4	6.2	5.5	5.1	5.1	4.4	4.4	4.4
24	15.4	13.4	11.8	10.8	10.1	9.4	9.1	8.9	7.9	7.0	6.8	6.7	6.5	5.8	5.3	5.3	4.6	4.6	4.6
25	16.0	14.0	12.3	11.3	10.5	9.8	9.5	9.3	8.3	7.3	7.1	7.0	6.8	6.0	5.5	5.5	4.8	4.8	4.8
26	16.6	14.6	12.7	11.7	10.9	10.1	9.9	9.6	8.6	7.5	7.4	7.3	7.0	6.2	5.7	5.7	4.9	4.9	4.9
27	17.3	15.1	13.2	12.2	11.3	10.5	10.3	10.0	8.9	7.8	7.7	7.6	7.3	6.5	5.9	5.9	5.1	5.1	5.1
28	17.9	15.7	13.7	12.6	11.8	10.9	10.6	10.4	9.2	8.1	8.0	7.8	7.6	6.7	6.2	6.2	5.3	5.3	5.3
29	18.6	16.2	14.2	13.1	12.2	11.3	11.0	10.7	9.6	8.4	8.3	8.1	7.8	7.0	6.4	6.4	5.5	5.5	5.5
30	19.2	16.8	14.7	13.5	12.6	11.7	11.4	11.1	9.9	8.7	8.6	8.4	8.1	7.2	6.6	6.6	5.7	5.7	5.7

Figure 7.8. Leaflet Drift Chart - 2500 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.5	.5	.4	.4	.3	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.2	.2
2	1.1	.9	.8	.8	.7	.6	.6	.6	.5	.5	.5	.4	.4	.4	.4	.4	.3	.3	.2
3	1.6	1.4	1.2	1.2	1.0	.9	.9	.9	.8	.8	.7	.7	.6	.6	.5	.5	.5	.5	.5
4	2.2	1.9	1.6	1.5	1.4	1.2	1.2	1.2	1.1	1.0	1.0	.9	.8	.8	.7	.7	.6	.6	.6
5	2.7	2.4	2.1	2.0	1.7	1.6	1.5	1.5	1.4	1.3	1.2	1.1	1.1	1.0	.9	.9	.8	.8	.8
6	3.2	2.8	2.5	2.3	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.1	1.1	1.1	1.0	1.0	1.0
7	3.8	3.3	2.9	2.7	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.5	1.5	1.3	1.3	1.3	1.1	1.1	1.1
8	4.3	3.8	3.3	3.1	2.7	2.5	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.5	1.4	1.4	1.3	1.3	1.3
9	4.9	4.2	3.7	3.5	3.1	2.8	2.7	2.6	2.4	2.3	2.2	2.0	1.9	1.7	1.6	1.6	1.4	1.4	1.4
10	5.4	4.7	4.1	3.9	3.4	3.1	3.0	2.9	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.8	1.6	1.6	1.6
11	5.9	5.2	4.5	4.3	3.7	3.4	3.3	3.2	3.0	2.8	2.6	2.4	2.3	2.1	2.0	2.0	1.8	1.8	1.8
12	6.5	5.6	4.9	4.7	4.1	3.7	3.6	3.5	3.2	3.0	2.9	2.6	2.5	2.3	2.2	2.2	1.9	1.9	1.9
13	7.0	6.1	5.3	5.1	4.4	4.0	3.9	3.8	3.5	3.3	3.1	2.9	2.7	2.5	2.3	2.3	2.1	2.1	2.1
14	7.6	6.6	5.7	5.5	4.8	4.3	4.2	4.1	3.8	3.5	3.4	3.1	2.9	2.7	2.5	2.5	2.2	2.2	2.2
15	8.1	7.1	6.2	5.9	5.1	4.7	4.5	4.3	4.1	3.8	3.6	3.3	3.2	2.9	2.7	2.7	2.4	2.4	2.4
16	8.6	7.5	6.6	6.2	5.4	5.0	4.8	4.6	4.3	4.0	3.8	3.5	3.4	3.0	2.9	2.9	2.6	2.6	2.6
17	9.2	8.0	7.0	6.6	5.8	5.3	5.1	4.9	4.6	4.3	4.1	3.7	3.6	3.2	3.1	3.1	2.7	2.7	2.7
18	9.7	8.5	7.4	7.0	6.1	5.6	5.4	5.2	4.9	4.5	4.3	4.0	3.8	3.4	3.2	3.2	2.9	2.9	2.9
19	10.1	8.9	7.8	7.4	6.5	5.9	5.7	5.5	5.1	4.8	4.6	4.2	4.0	3.6	3.4	3.4	3.0	3.0	3.0
20	10.8	9.4	8.2	7.8	6.8	6.2	6.0	5.8	5.4	5.0	4.8	4.4	4.2	3.8	3.6	3.6	3.2	3.2	3.2
21	11.3	9.9	8.6	8.2	7.1	6.5	6.3	6.1	5.7	5.3	5.0	4.6	4.4	4.0	3.8	3.8	3.4	3.4	3.4
22	11.9	10.3	9.0	8.6	7.5	6.8	6.6	6.4	5.9	5.5	5.3	4.8	4.6	4.2	4.0	4.0	3.5	3.5	3.5
23	12.4	10.8	9.4	9.0	7.8	7.1	6.9	6.8	6.2	5.8	5.5	5.1	4.8	4.4	4.1	4.1	3.7	3.7	3.7
24	13.0	11.3	9.8	9.4	8.2	7.4	7.2	7.0	6.5	6.0	5.8	5.3	5.0	4.6	4.3	4.3	3.8	3.8	3.8
25	13.5	11.8	10.3	9.8	8.5	7.7	7.5	7.3	6.8	6.3	6.0	5.5	5.3	4.8	4.5	4.5	4.0	4.0	4.0
26	14.0	12.2	10.7	10.1	8.8	8.1	7.8	7.5	7.0	6.5	6.2	5.7	5.5	4.9	4.7	4.7	4.2	4.2	4.2
27	14.6	12.7	11.1	10.5	9.2	8.4	8.1	7.8	7.3	6.8	6.5	5.9	5.7	5.1	4.9	4.9	4.3	4.3	4.3
28	15.1	13.2	11.5	10.9	9.5	8.7	8.4	8.1	7.6	7.0	6.7	6.2	5.9	5.3	5.0	5.0	4.5	4.5	4.5
29	15.7	13.6	11.9	11.3	9.9	9.0	8.7	8.4	7.8	7.3	7.0	6.4	6.1	5.5	5.2	5.2	4.6	4.6	4.6
30	16.2	14.1	12.3	11.7	10.2	9.3	9.0	8.7	8.1	7.5	7.2	6.6	6.3	5.7	5.4	5.4	4.8	4.8	4.8

Figure 7.9. Leaflet Drift Chart - 2000 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.5	.4	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1
2	.9	.8	.7	.6	.6	.5	.5	.5	.5	.4	.4	.4	.4	.3	.3	.3	.3	.3	.3
3	1.4	1.2	1.0	.9	.9	.8	.8	.7	.7	.6	.6	.6	.5	.5	.5	.5	.4	.4	.4
4	1.8	1.7	1.4	1.2	1.2	1.1	1.0	1.0	.9	.8	.8	.8	.7	.6	.6	.6	.5	.5	.5
5	2.3	2.0	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	1.0	.9	.8	.8	.8	.7	.7	.7
6	2.7	2.3	2.0	1.9	1.8	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	.9	.9	.8	.8	.8
7	3.2	2.7	2.4	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.1	1.1	1.1	.9	.9	.9
8	3.6	3.1	2.7	2.6	2.5	2.2	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.0	1.0	1.0
9	4.1	3.5	3.1	2.8	2.7	2.4	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.4	1.4	1.4	1.2	1.2	1.2
10	4.5	3.9	3.4	3.1	3.0	2.7	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.6	1.5	1.5	1.3	1.3	1.3
11	5.0	4.3	3.7	3.4	3.3	3.0	2.8	2.6	2.5	2.3	2.2	2.1	2.0	1.8	1.7	1.7	1.4	1.4	1.4
12	5.4	4.7	4.1	3.7	3.6	3.2	3.0	2.9	2.8	2.5	2.4	2.3	2.2	1.9	1.8	1.8	1.6	1.6	1.6
13	5.9	5.1	4.4	4.0	3.9	3.5	3.3	3.1	3.0	2.7	2.6	2.5	2.3	2.1	2.0	2.0	1.7	1.7	1.7
14	6.3	5.5	4.8	4.3	4.2	3.8	3.5	3.4	3.2	2.9	2.8	2.7	2.5	2.2	2.1	2.1	1.8	1.8	1.8
15	6.8	5.9	5.1	4.7	4.5	4.1	3.8	3.6	3.5	3.2	3.0	2.9	2.7	2.4	2.3	2.3	2.0	2.0	2.0
16	7.2	6.2	5.4	5.0	4.8	4.3	4.0	3.8	3.7	3.4	3.2	3.0	2.9	2.6	2.4	2.4	2.1	2.1	2.1
17	7.7	6.6	5.8	5.3	5.1	4.6	4.3	4.1	3.9	3.6	3.4	3.2	3.1	2.7	2.6	2.6	2.2	2.2	2.2
18	8.1	7.0	6.1	5.6	5.4	4.9	4.5	4.3	4.1	3.8	3.6	3.4	3.2	2.9	2.7	2.7	2.3	2.3	2.3
19	8.6	7.4	6.5	5.9	5.7	5.1	4.8	4.6	4.4	4.0	3.8	3.6	3.4	3.0	2.9	2.9	2.5	2.5	2.5
20	9.0	7.8	6.8	6.2	6.0	5.4	5.0	4.8	4.6	4.4	4.0	3.8	3.6	3.2	3.0	3.0	2.6	2.6	2.6
21	9.5	8.2	7.1	6.5	6.3	5.7	5.3	5.0	4.8	4.4	4.2	4.0	3.8	3.4	3.2	3.2	2.7	2.7	2.7
22	9.9	8.6	7.5	6.8	6.6	5.9	5.5	5.3	5.1	4.6	4.4	4.2	4.0	3.5	3.3	3.3	2.9	2.9	2.9
23	10.3	9.0	7.8	7.1	6.9	6.2	5.8	5.5	5.3	4.8	4.6	4.4	4.1	3.7	3.5	3.5	3.0	3.0	3.0
24	10.8	9.4	8.2	7.4	7.2	6.5	6.0	5.8	5.5	5.0	4.8	4.6	4.3	3.8	3.6	3.6	3.1	3.1	3.1
25	11.3	9.8	8.5	7.7	7.5	6.8	6.3	6.0	5.8	5.3	5.0	4.8	4.5	4.0	3.8	3.8	3.3	3.3	3.3
26	11.7	10.1	8.8	8.1	7.8	7.0	6.5	6.2	6.0	5.5	5.2	4.9	4.7	4.2	3.9	3.9	3.4	3.4	3.4
27	12.2	10.5	9.2	8.4	8.1	7.3	6.8	6.5	6.2	5.7	5.4	5.1	4.9	4.3	4.1	4.1	3.5	3.5	3.5
28	12.6	10.9	9.5	8.7	8.4	7.6	7.0	6.7	6.4	5.9	5.6	5.3	5.0	4.5	4.2	4.2	3.6	3.6	3.6
29	13.1	11.3	9.9	9.0	8.7	7.8	7.3	7.0	6.7	6.1	5.8	5.5	5.2	4.6	4.4	4.4	3.8	3.8	3.8
30	13.5	11.7	10.2	9.3	9.0	8.1	7.5	7.2	6.9	6.3	6.0	5.7	5.4	4.8	4.5	4.5	3.9	3.9	3.9

Figure 7.10. Leaflet Drift Chart - 1500 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.4	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1	.1	.1
2	.7	.6	.5	.5	.5	.4	.4	.4	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2
3	1.1	.9	.8	.8	.7	.6	.6	.5	.5	.5	.5	.4	.4	.4	.3	.3	.3	.3	.3
4	1.4	1.2	1.0	1.0	1.0	.8	.8	.7	.7	.6	.6	.6	.5	.5	.4	.4	.4	.4	.4
5	1.8	1.5	1.3	1.3	1.2	1.0	.9	.9	.9	.8	.8	.7	.7	.6	.6	.6	.5	.5	.5
6	2.1	1.8	1.6	1.5	1.4	1.2	1.1	1.1	1.0	1.0	1.0	.8	.8	.7	.7	.7	.6	.6	.6
7	2.5	2.1	1.8	1.8	1.7	1.4	1.3	1.3	1.2	1.1	1.1	1.0	.9	.8	.8	.8	.7	.7	.7
8	2.8	2.4	2.1	2.0	1.9	1.6	1.5	1.4	1.4	1.3	1.3	1.1	1.0	1.0	.9	.9	.8	.8	.8
9	3.2	2.7	2.3	2.3	2.2	1.8	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.0	1.0	.9	.9	.9
10	3.5	3.0	2.6	2.5	2.4	2.0	1.9	1.8	1.7	1.6	1.6	1.4	1.3	1.2	1.1	1.1	1.0	1.0	1.0
11	3.9	3.3	2.9	2.8	2.6	2.2	2.1	2.0	1.9	1.8	1.8	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.1
12	4.2	3.6	3.1	3.0	2.9	2.4	2.3	2.2	2.0	1.9	1.9	1.7	1.6	1.4	1.3	1.3	1.2	1.2	1.2
13	4.6	3.9	3.4	3.3	3.1	2.6	2.5	2.3	2.2	2.1	2.1	1.8	1.7	1.6	1.4	1.4	1.3	.13	1.3
14	4.9	4.2	3.6	3.5	3.4	2.8	2.7	2.5	2.4	2.2	2.2	2.0	1.8	1.7	1.5	1.5	1.4	1.4	1.4
15	5.3	4.5	3.9	3.8	3.6	3.0	2.9	2.7	2.6	2.4	2.4	2.1	2.0	1.8	1.7	1.7	1.5	1.5	1.5
16	5.6	4.8	4.2	4.0	3.8	3.2	3.0	2.9	2.7	2.6	2.6	2.2	2.1	1.9	1.8	1.8	1.6	1.6	1.6
17	6.0	5.1	4.4	4.3	4.1	3.4	3.2	3.1	2.9	2.7	2.7	2.4	2.2	2.0	1.9	1.9	1.7	1.7	1.7
18	6.3	5.4	4.7	4.5	4.3	3.6	3.4	3.2	3.1	2.9	2.9	2.5	2.3	2.2	2.0	2.0	1.8	1.8	1.8
19	6.7	5.7	4.9	4.8	4.6	3.8	3.6	3.4	3.2	3.0	3.0	2.7	2.5	2.3	2.1	2.1	1.9	1.9	1.9
20	7.0	6.0	5.2	5.0	4.8	4.0	3.8	3.6	3.4	3.2	3.2	2.8	2.6	2.4	2.2	2.2	2.0	2.0	2.0
21	7.4	6.3	5.5	5.3	5.0	4.2	4.0	3.8	3.6	3.4	3.4	2.9	2.7	2.5	2.3	2.3	2.1	2.1	2.1
22	7.7	6.6	5.7	5.5	5.3	4.4	4.2	4.0	3.7	3.5	3.5	3.1	2.9	2.6	2.4	2.4	2.2	2.2	2.2
23	8.1	6.9	6.0	5.8	5.5	4.6	4.4	4.1	3.9	3.7	3.7	3.2	3.0	2.8	2.5	2.5	2.3	2.3	2.3
24	8.4	7.2	6.2	6.0	5.8	4.8	4.6	4.3	4.1	3.8	3.8	3.4	3.1	2.9	2.6	2.6	2.4	2.4	2.4
25	8.8	7.5	6.5	6.3	6.0	5.0	4.8	4.5	4.3	4.0	4.0	3.5	3.3	3.0	2.8	2.8	2.5	2.5	2.5
26	9.1	7.8	6.7	6.5	6.2	5.2	4.9	4.7	4.4	4.2	4.2	3.6	3.4	3.1	2.9	2.9	2.6	2.6	2.6
27	9.5	8.1	7.0	6.8	6.5	5.4	5.1	4.9	4.6	4.3	4.3	3.8	3.5	3.2	3.0	3.0	2.7	2.7	2.7
28	9.8	8.4	7.3	7.0	6.7	5.6	5.3	5.0	4.8	4.5	4.5	3.9	3.6	3.4	3.1	3.1	2.8	2.8	2.8
29	10.2	8.7	7.5	7.3	7.0	5.8	5.5	5.2	4.9	4.6	4.6	4.1	3.7	3.5	3.2	3.2	2.9	2.9	2.9
30	10.5	9.0	7.8	7.5	7.2	6.0	5.7	5.4	5.1	4.8	4.8	4.2	3.9	3.6	3.3	3.3	3.0	3.0	3.0

Figure 7.11. Leaflet Drift Chart - 1000 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.3	.2	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1	.08	.08	.08	.07	.07	.07	.07
2	.5	.4	.4	.4	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1
3	.8	.7	.6	.5	.5	.5	.4	.4	.4	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2
4	1.0	.9	.8	.7	.6	.6	.6	.5	.5	.4	.4	.4	.4	.3	.3	.3	.3	.3	.3
5	1.3	1.1	1.0	.9	.8	.8	.7	.7	.6	.6	.6	.5	.5	.4	.4	.4	.4	.4	.4
6	1.5	1.3	1.1	1.1	1.0	.9	.8	.8	.7	.7	.7	.6	.5	.5	.5	.5	.4	.4	.4
7	1.8	1.5	1.3	1.3	1.1	1.1	1.0	.9	.8	.8	.8	.7	.6	.6	.6	.6	.5	.5	.5
8	2.0	1.8	1.5	1.4	1.3	1.2	1.1	1.0	1.0	.9	.9	.8	.7	.6	.6	.6	.6	.6	.6
9	2.3	2.0	1.7	1.6	1.4	1.4	1.3	1.2	1.1	1.0	1.0	.9	.8	.7	.7	.7	.6	.6	.6
10	2.5	2.2	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0	.9	.8	.8	.8	.7	.7	.7
11	2.7	2.4	2.1	2.0	1.8	1.7	1.5	1.4	1.3	1.2	1.2	1.1	1.0	.9	.9	.9	.8	.8	.8
12	3.0	2.6	2.3	2.2	1.9	1.8	1.7	1.6	1.4	1.3	1.3	1.2	1.1	1.0	1.0	1.0	.8	.8	.8
13	3.3	2.9	2.5	2.3	2.1	2.0	1.8	1.7	1.6	1.4	1.4	1.3	1.2	1.0	1.0	1.0	.9	.9	.9
14	3.5	3.1	2.7	2.5	2.2	2.1	2.0	1.8	1.7	1.5	1.5	1.4	1.3	1.1	1.1	1.1	1.0	1.0	1.0
15	3.8	3.3	2.9	2.7	2.4	2.3	2.1	2.0	1.8	1.7	1.7	1.5	1.4	1.2	1.2	1.2	1.1	1.1	1.1
16	4.0	3.5	3.0	2.9	2.6	2.4	2.2	2.1	1.9	1.8	1.8	1.6	1.4	1.3	1.3	1.3	1.1	1.1	1.1
17	4.3	3.7	3.2	3.1	2.7	2.6	2.4	2.2	2.0	1.9	1.9	1.7	1.5	1.4	1.4	1.4	1.2	1.2	1.2
18	4.5	4.0	3.4	3.2	2.9	2.7	2.5	2.3	2.2	2.0	2.0	1.8	1.6	1.4	1.4	1.4	1.3	1.3	1.3
19	4.8	4.2	3.6	3.4	3.0	2.9	2.7	2.5	2.3	2.1	2.1	1.9	1.7	1.5	1.5	1.5	1.3	1.3	1.3
20	5.0	4.4	3.8	3.6	3.2	3.0	2.8	2.6	2.4	2.2	2.2	2.0	1.8	1.6	1.6	1.6	1.4	1.4	1.4
21	5.3	4.6	4.0	3.8	3.4	3.2	2.9	2.7	2.5	2.3	2.3	2.1	1.9	1.7	1.7	1.7	1.5	1.5	1.5
22	5.5	4.8	4.2	4.0	3.5	3.3	3.1	2.9	2.6	2.4	2.4	2.2	2.0	1.8	1.8	1.8	1.5	1.5	1.5
23	5.8	5.1	4.4	4.1	3.7	3.5	3.2	3.0	2.8	2.5	2.5	2.3	2.1	1.8	1.8	1.8	1.6	1.6	1.6
24	6.0	5.3	4.6	4.3	3.8	3.6	3.4	3.1	2.9	2.6	2.6	2.4	2.2	1.9	1.9	1.9	1.7	1.7	1.7
25	6.3	5.5	4.8	4.5	4.0	3.8	3.5	3.3	3.0	2.8	2.8	2.5	2.3	2.0	2.0	2.0	1.8	1.8	1.8
26	6.5	5.7	4.9	4.7	4.2	3.9	3.6	3.4	3.1	2.9	2.9	2.6	2.3	2.1	2.1	2.1	1.8	1.8	1.8
27	6.8	5.9	5.1	4.9	4.3	4.1	3.8	3.5	3.2	3.0	3.0	2.7	2.4	2.2	2.2	2.2	1.9	1.9	1.9
28	7.0	6.2	5.3	5.0	4.5	4.2	3.9	3.6	3.4	3.1	3.1	2.8	2.5	2.2	2.2	2.2	1.9	1.9	1.9
29	7.3	6.4	5.5	5.2	4.6	4.4	4.1	3.7	3.5	3.2	3.2	2.9	2.6	2.3	2.3	2.3	2.0	2.0	2.0
30	7.5	6.6	5.7	5.4	4.8	4.5	4.2	3.9	3.6	3.3	3.3	3.0	2.7	2.4	2.4	2.4	2.1	2.1	2.1

Figure 7.12. Leaflet Drift Chart - 500 Feet.

WIND SPD **DESCENT RATE (V_0)**

	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.7
1	.2	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.04	.04	.04	.04	.04	.04	.04
2	.3	.3	.2	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3	.5	.4	.4	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1
4	.6	.5	.5	.4	.4	.4	.3	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.2
5	.8	.7	.6	.6	.5	.5	.4	.4	.4	.4	.4	.3	.3	.2	.2	.2	.2	.2	.2
6	.9	.8	.7	.7	.6	.5	.5	.5	.5	.4	.4	.4	.4	.2	.2	.2	.2	.2	.2
7	1.1	.9	.8	.8	.7	.6	.6	.6	.6	.5	.5	.4	.4	.3	.3	.3	.3	.3	.3
8	1.2	1.0	1.0	.9	.8	.7	.6	.6	.6	.6	.6	.5	.5	.3	.3	.3	.3	.3	.3
9	1.4	1.2	1.1	1.0	.9	.8	.7	.7	.7	.6	.6	.5	.5	.4	.4	.4	.4	.4	.4
10	1.5	1.3	1.2	1.1	1.0	.9	.8	.8	.8	.7	.7	.6	.6	.4	.4	.4	.4	.4	.4
11	1.7	1.4	1.3	1.2	1.1	1.0	.9	.9	.9	.8	.8	.7	.7	.4	.4	.4	.4	.4	.4
12	1.8	1.6	1.4	1.3	1.2	1.1	1.0	1.0	1.0	.8	.8	.7	.7	.5	.5	.5	.5	.5	.5
13	2.0	1.7	1.6	1.4	1.3	1.2	1.0	1.0	1.0	.9	.9	.8	.8	.5	.5	.5	.5	.5	.5
14	2.1	1.8	1.7	1.5	1.4	1.3	1.1	1.1	1.1	1.0	1.0	.8	.8	.6	.6	.6	.6	.6	.6
15	2.3	1.9	1.8	1.7	1.5	1.4	1.2	1.2	1.2	1.1	1.1	.9	.9	.6	.6	.6	.6	.6	.6
16	2.4	2.1	1.9	1.8	1.6	1.4	1.3	1.3	1.3	1.1	1.1	1.0	1.0	.6	.6	.6	.6	.6	.6
17	2.6	2.2	2.0	1.9	1.7	1.5	1.4	1.4	1.4	1.2	1.2	1.0	1.0	.7	.7	.7	.7	.7	.7
18	2.7	2.3	2.2	2.0	1.8	1.6	1.4	1.4	1.4	1.3	1.3	1.1	1.1	.7	.7	.7	.7	.7	.7
19	2.9	2.5	2.3	2.1	1.9	1.7	1.5	1.5	1.5	1.3	1.3	1.1	1.1	.8	.8	.8	.8	.8	.8
20	3.0	2.6	2.4	2.2	2.0	1.8	1.6	1.6	1.6	1.4	1.4	1.2	1.2	.8	.8	.8	.8	.8	.8
21	3.2	2.7	2.5	2.3	2.1	1.9	1.7	1.7	1.7	1.5	1.5	1.3	1.3	.8	.8	.8	.8	.8	.8
22	3.3	2.9	2.6	2.4	2.2	2.0	1.8	1.8	1.8	1.5	1.5	1.3	1.3	.9	.9	.9	.9	.9	.9
23	3.5	3.0	2.8	2.5	2.3	2.1	1.8	1.8	1.8	1.6	1.6	1.4	1.4	.9	.9	.9	.9	.9	.9
24	3.6	3.1	2.9	2.6	2.4	2.2	1.9	1.9	1.9	1.7	1.7	1.4	1.4	1.0	1.0	1.0	1.0	1.0	1.0
25	3.8	3.3	3.0	2.8	2.5	2.3	2.0	2.0	2.0	1.8	1.8	1.5	1.5	1.0	1.0	1.0	1.0	1.0	1.0
26	3.9	3.4	3.1	2.9	2.6	2.3	2.1	2.1	2.1	1.8	1.8	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0
27	4.1	3.5	3.2	3.0	2.7	2.4	2.2	2.2	2.2	1.9	1.9	1.6	1.6	1.1	1.1	1.1	1.1	1.1	1.1
28	4.2	3.6	3.4	3.1	2.8	2.5	2.2	2.2	2.2	1.9	1.9	1.7	1.7	1.1	1.1	1.1	1.1	1.1	1.1
29	4.4	3.7	3.5	3.2	2.9	2.6	2.3	2.3	2.3	2.0	2.0	1.7	1.7	1.2	1.2	1.2	1.2	1.2	1.2
30	4.5	3.9	3.6	3.3	3.0	2.7	2.4	2.4	2.4	2.1	2.1	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2

7.5. High Altitude Release Procedures. High altitude leaflet releases present unique problems to the mission planner, since even a moderate change in wind direction or speed can cause the leaflet release track to be displaced several miles. Depending on the characteristics of the leaflet, the average descent time from 25,000 feet can be over five hours. Wind information, therefore, must take into account changes expected in the lower altitude winds several hours after the planned release time. Missions may be targeted for well defined urban/border areas, or for large expanses of sparsely populated rural territory. Coverage of the required area is so dependent on the falling characteristics of the leaflet that the selection of size and paper weight should be confirmed only after study of the required flight profile, wind patterns, and required target coverage has been made.

7.5.1. Instructions for completing AF Form 4016, **High Altitude Leaflet Computations** (**Figure 7.13.**):

7.5.1.1. Enter the table on the back side of AF Form 4016 (Figure 7.6.) with the leaflet size and paper weight to find Vo and RtTo. Also note whether the leaflet is an autorotator or non-autorotator. Enter the results at the top of Section I of AF Form 4016.

7.5.1.2. Obtain forecast winds in 5,000 foot intervals up to the highest anticipated drop altitude. Enter in the wind speed and direction columns of the AF Form 4016, Section I.

7.5.1.3. .Enter the table on the back side of AF Form 4016 (**Figure 7.14.**) with the leaflet type (autorotator/non-autorotator) and ground rate of descent (V_o). Find the time factor in hours for each 5,000 foot altitude block and enter in Section I. If the average target elevation is above 1000 feet MSL, multiply the time factor for the 0-5,000 foot block by the factor (5,000 - Target Elev)/ 5,000.

7.5.1.4. For each 5,000 foot block, calculate the drift distance and enter in Section I. Starting with the lowest altitude block, plot the drift vectors (drift distance and wind direction) end to end on an appropriately scaled chart (1:1,000,000 scale or larger). Each vector is plotted into the wind direction, and the first vector originates from the center of the target area, **Figure 7.13.**

7.5.1.5. .Measure the distance and azimuth from the end of each vector to the target center and enter in Section II. Calculate the length of the major axis for each 5,000 foot drop altitude increment on Section II as shown in **Figure 7.13.**

7.5.1.6. On the chart, compare the required target area with the major axis length for each 5,000 foot block to determine the required drop altitude. Note that the major axis is to be measured along the Measured Net Wind Direction for that drop altitude. Enter the selected drop altitude in Section III. If at maximum drop altitude the major axis is still too small, either:

7.5.1.6.1. Select a new leaflet size or weight with a larger coefficient of variation or slower rate of fall.

7.5.1.6.2. Reduce the required major axis by making two or more passes, **Figure 7.16.**

7.5.1.6.3. Postpone the mission until stronger winds are forecast.

7.5.1.6.4. Use a different drop platform with a higher altitude capability.

7.5.1.7. Determine the desired release track(s). The release track start and end points (A and B in **Figure 7.16.**) are located at the drift distance (52.2 nm in **Figure 7.13.**) upwind along the drop altitude net wind direction from points a and b.

Figure 7.13. High Altitude Leaflet Computation Sample.

HIGH ALTITUDE LEAFLET COMPUTATIONS

SECTION I

Paper Size: 6"x4" Weight: 20# Average Target Elevation: 2500

TABLE 1: V_o 4.0 $R_t\sqrt{T_o}$: 0.46 Autorotator Non-Autorator (circle one)

Pressure Alt Interval (1000')	Time Factor (Table 2) (hours)	x	Wind Speed (knots)	= Drift Distance (nm)	Wind Direction (Degrees)
0-5	0.17*	x	20	3.4	220
5-10	0.33	x	25	8.3	260
10-15	0.31	x	40	12.4	250
15-20	0.28	x	50	14.0	250
20-25	0.25	x	55	13.8	260
25-30	$*0.34 \times \frac{(5000-2500)}{(5000)}$				
30-35					

SECTION II

Drop Altitude (feet)	Measured Drift Distance (nm)	x	$R_t\sqrt{T_o}$	+	No-Wind Length (nm)	= Major Axis (nm)	Measured Net Wind Direction
10,000	11.1	x	0.46	+	0.8	5.9	249º
15,000	23.5	x	0.46	+	1.2	12.0	249º
20,000	37.5	x	0.46	+	1.6	18.9	250º
25,000	52.2	x	0.46	+	2.1	25.7	252º
30,000		x			2.5		
35,000		x			2.9		

SECTION II

Selected Drop Altitude: 25,000 feet

No-Wind Length (nm) = Drop Altitude (feet) / 12,152 = 2.1 nm

Minor Axis = (Maximum Deviation Value (nm) x $R_t\sqrt{T_o}$ + No - Wind Length (nm)

= (1.8 x 0.46) + 2.1 = 2.9 nm

AF Form 4016 Replaces AFSOC Form 3, Jul 89

Figure 7.14. Reverse Side of AF Form 4016 (Reverse).

TIME FACTORS (HOURS) FOR THE DESCENT OF LEAFLETS THROUGH 5,000-FT INCREMENTS
NON - AUTOROTATORS

Gnd Dscnt Rt			Altitude Interval (X 1000ft)				
(ft/sec)	0-5	5-10	10-15	15-20	20-25	25-30	30-35
1.0	1.37	1.31	1.22	1.11	0.98	0.84	0.71
2.0	0.69	0.66	0.61	0.56	0.49	0.42	0.35
2.1	0.65	0.62	0.58	0.53	0.47	0.40	0.34
2.2	0.62	0.60	0.56	0.50	0.45	0.38	0.32
2.3	0.60	0.57	0.53	0.48	0.43	0.37	0.31
2.4	0.57	0.55	0.51	0.46	0.41	0.35	0.29
2.5	0.55	0.52	0.49	0.44	0.39	0.34	0.28
2.6	0.53	0.50	0.47	0.43	0.38	0.32	0.27
2.7	0.51	0.49	0.45	0.41	0.36	0.31	0.26
2.8	0.49	0.47	0.44	0.40	0.35	0.30	0.25
2.9	0.47	0.45	0.42	0.38	0.34	0.29	0.24
3.0	0.46	0.44	0.41	0.37	0.33	0.28	0.24
3.1	0.44	0.42	0.39	0.36	0.32	0.27	0.23
3.2	0.43	0.41	0.38	0.35	0.31	0.26	0.22
3.3	0.42	0.40	0.37	0.34	0.30	0.26	0.25
3.4	0.40	0.39	0.36	0.33	0.29	0.25	0.21
3.5	0.39	0.37	0.35	0.32	0.28	0.24	0.20
3.6	0.38	0.36	0.34	0.31	0.27	0.23	0.20
3.7	0.37	0.35	0.33	0.30	0.27	0.23	0.19
3.8	0.36	0.35	0.32	0.29	0.26	0.22	0.19
3.9	0.35	0.34	0.31	0.28	0.25	0.22	0.18
4.0	0.34	0.33	0.31	0.28	0.25	0.21	0.18
4.1	0.33	0.32	0.30	0.27	0.24	0.21	0.17
4.2	0.33	0.31	0.29	0.26	0.23	0.20	0.17
4.3	0.32	0.31	0.28	0.26	0.23	0.20	0.16
4.4	0.31	0.30	0.28	0.25	0.22	0.19	0.16
4.5	0.30	0.29	0.27	0.25	0.22	0.19	0.16
4.6	0.30	0.29	0.27	0.24	0.21	0.18	0.15
4.7	0.29	0.28	0.26	0.24	0.21	0.18	0.15
4.8	0.29	0.27	0.25	0.23	0.20	0.18	0.15
4.9	0.28	0.27	0.25	0.23	0.20	0.17	0.14
5.0	0.27	0.26	0.24	0.22	0.20	0.17	0.14

TIME FACTORS (HOURS) FOR THE DESCENT OF LEAFLETS THROUGH 5,000-FT INCREMENTS

Gnd Dscnt Rt			Altitude Interval (X 1000 ft)				
(ft/sec)	0-5	5-10	10-15	15-20	20-25	25-30	30-35
1.0	1.36	1.28	1.18	1.07	0.96	0.86	0.76
1.1	1.24	1.16	1.07	0.97	0.87	0.78	0.69
1.2	1.13	1.06	0.98	0.89	0.80	0.71	0.63
1.3	1.05	0.98	0.91	0.82	0.74	0.66	0.58
1.4	0.97	0.91	0.84	0.76	0.69	0.61	0.54
1.5	0.91	0.85	0.78	0.71	0.64	0.57	0.50
1.6	0.85	0.80	0.74	0.67	0.60	0.54	0.47
1.7	0.80	0.75	0.69	0.63	0.57	0.50	0.45
1.8	0.76	0.71	0.65	0.59	0.53	0.48	0.42
1.9	0.72	0.67	0.62	0.56	0.51	0.45	0.40
2.0	0.68	0.64	0.59	0.53	0.48	0.43	0.38
2.1	0.65	0.61	0.56	0.51	0.46	0.41	0.36
2.2	0.62	0.58	0.53	0.49	0.44	0.39	0.34
2.3	0.59	0.56	0.51	0.47	0.42	0.37	0.33
2.4	0.57	0.53	0.49	0.45	0.40	0.36	0.32
2.5	0.54	0.51	0.47	0.43	0.38	0.34	0.30
2.6	0.52	0.49	0.45	0.41	0.37	0.33	0.29
2.7	0.50	0.47	0.44	0.40	0.36	0.32	0.28
2.8	0.49	0.46	0.42	0.38	0.34	0.31	0.27
2.9	0.47	0.44	0.41	0.37	0.33	0.30	0.26
3.0	0.45	0.43	0.39	0.36	0.32	0.29	0.25
3.1	0.44	0.41	0.38	0.35	0.31	0.28	0.24
3.2	0.43	0.40	0.37	0.33	0.30	0.27	0.24
3.3	0.41	0.39	0.36	0.32	0.29	0.26	0.23
3.4	0.40	0.38	0.35	0.31	0.28	0.25	0.22
3.5	0.39	0.36	0.34	0.31	0.27	0.24	0.22

AF Form 4016 (Reverse)

7.5.1.8. Use Section III of AF Form 4016 to calculate the minor axis as follows:

7.5.1.8.1. Divide the selected drop altitude by 12,152 to obtain the no-wind minor axis in nm (2.1 in **Figure 7.13.**).

7.5.1.8.2. To adjust for minor axis spread caused by changing wind direction between surface and drop altitude, measure the maximum lateral distance the wind vectors deviate from the net (drop altitude) drift vector (1.8 nm in **Figure 7.15.**).

7.5.1.8.3. Add the spread factor (R_t/T_o) to the sum of (a) and (b) to obtain the minor axis.

7.5.1.8.4. Use the bottom section of AF Form 4016, High Altitude Leaflet Computations, to calculate and record the items in the Drop Information Summary for use in the mission and in-flight briefings.

Figure 7.15. Drift Vector Plot.

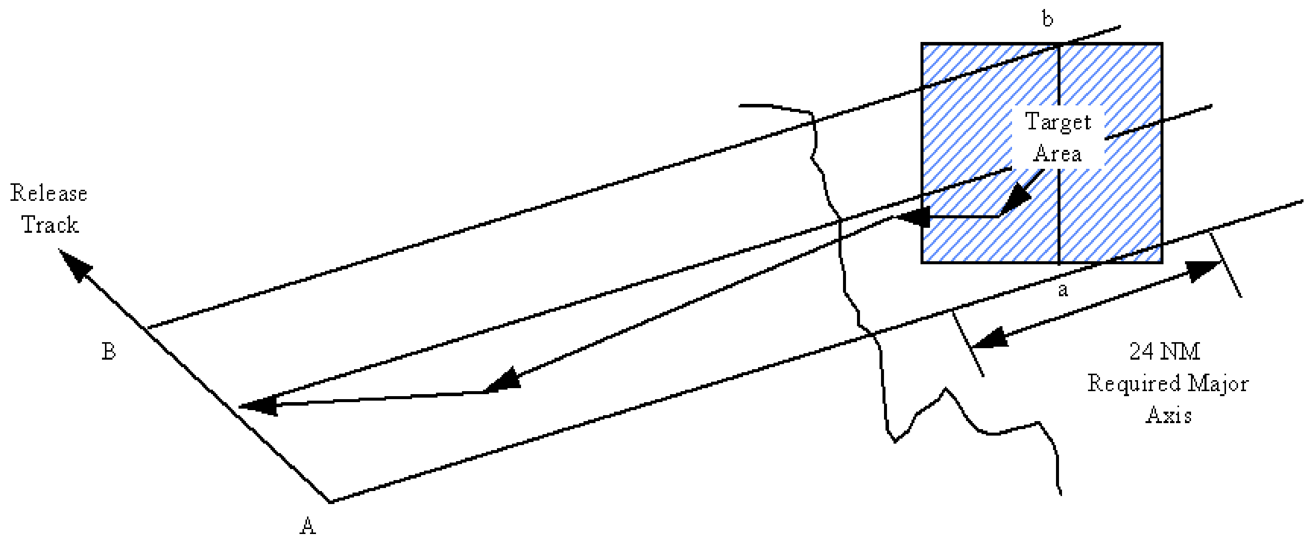
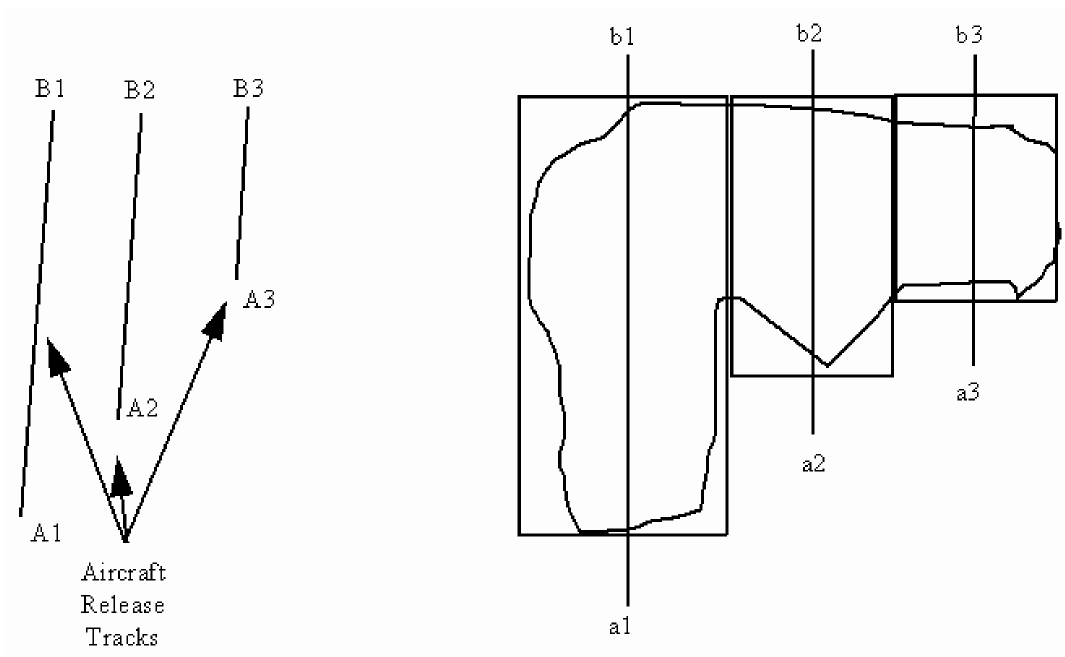


Figure 7.16. Using Multiple Passes to Expand Major Axis.



7.6. Accuracy Limitations. The accuracy of the low altitude and high altitude leaflet computation methods are only as good as the wind data upon which they so heavily depend. If complete coverage of a defined area is more critical than avoiding spillover, points A and B, in **Figure 7.16.**, can be defined farther apart to account for possible wind direction variation. The required major axis length can also be expanded by 10% to allow for variation in wind speed. In addition to wind variations, other factors can prevent the target audience from receiving the desired density of leaflets. Mountains will create a "shadow" effect downwind, as leaflets land on their upwind side. High humidity during printing and processing may cause leaflets to stick together or even freeze at high altitudes, causing them to fall nearly straight down. The average rate of fall may vary significantly from the values shown in Table 1 for various reasons. To allow for these variations, select leaflets with a relatively high spread factor so the probability of covering the target area will improve. Normally, the use of leaflets with spread factors less than 0.20 should be avoided.

Chapter 8

C-141/C-17/C-5 AERIAL DELIVERY DATA

8.1. C-141/C-17/C-5 Airdrop Airspeeds (in knots indicated airspeed KIAS): Aerial delivery airspeeds are a function of the force required to inflate the parachute and the airdrop altitude to minimize damage to the airdropped object.

Table 8.1. Airdrop Airspeeds.

	C-141/C-5	C-17
Personnel Static Line	130-135	130 - 135
Personnel HALO and HAHO	1.3 Vs (130 min - 180 max)	138 - 145
Equipment/Combination*	150	145 +/- 5
CDS/Combination ***NOTE: Includes Free Fall, High Velocity CDS, Wedge, Ahkio Sled, and CRRC**	150	145 +/- 5
Door Bundle	130-135	130 - 135
SATB (Not Applicable to C-17)	Same as type load simulated	Not Applicable

NOTE: Combination drops will use the highest airdrop KIAS

8.2. C-141/C-17/C-5 Airdrop Wind Limitations. Wind limits in **Table 8.2.** apply only to Air Force loads. Non-Air Force load wind limitations are at the discretion of the supported unit DZSO.

Table 8.2. Airdrop Wind Limitations.

Type Drop	Air Force Surface Wind Limits (kts)	Non-Air Force Surface Wind Limits (kts)
Equipment with Ground Disconnects	17	Discretion of unit DZSO
CDS using G-12 Parachutes	13	“
CDS using G-13/14 Parachutes	20	“
HAARS or High Velocity CDS	No Restriction	“
SATB (All)	25	“
Personnel - Static Line (Land)	13	“
Personnel - Static Line (Water)	17	“
HALO/HAHO - Military Free Fall (MFF) (Land)	18	“
HALO/HAHO - Military Free Fall (MFF) (Water)	20	“

8.3. C-141/C-17/C-5 Airdrop Altitudes: These altitudes were determined through testing conducted by the US Army Airborne Board, USAFALCENT, and Natick Labs, and are the basis for determining operational altitudes. Use operational minimum altitudes depicted to compute indicated altitudes on AF Forms 4013 and 4018.

AIRDROP ALTITUDES

Table 8.3. Airdrop Altitudes.

Type of Airdrop/Chute	Cluster Size (# of canopies or bundles for G-12D)	Operational Mission Altitude (feet AGL)
Personnel: (all chutes)		
Combat Operations (War time or contingency)		Jointly determined by Airborne and Airlift Commanders
Tactical Training		800
Basic Airborne Trainees		1250
HALO (minimum opening)		2500
SATB-P		500
CDS:		
G-12D	Single canopy 1 - 6 bundles	475
	7 or more bundles	575
	2 or 3	525
G-12E	Single canopy 1 - 40 bundles 130 KIAS	425
	Single canopy 1 - 40 bundles 140-150 KIAS	375
	2 or 3	550
G-13	1 or 2	400
	3	500
G-14	1 or 2	300
	3	400
12'/22' high velocity ring slot parachute (Hi-V) (see caution)		100 plus vertical distance for the load being dropped
26' high velocity ring slot parachute (Hi-V)		1100 (see caution)
SATB-C		See type chute being simulated
Heavy Equipment:		
G-12D		650
G-12E		550
G-11A	1	900
	2 - 7	1100
	8	1300
G-11B	1	700
	2 - 4	750
	5 - 7	1100
	8	1300
G-11C	8	1300
SATB-H		See type chute being simulated
Door Bundle (G-13/14, T-10, and T-7A)		300
RECOVERY KIT (22' Ring Slot)	Land	
	Water	300 feet (maximum)
HSLLADS		

NOTE: Minimum drop altitude for HE using the 5000 pound parachute release is 1000 feet AGL, or by parachute type, whichever is higher.
CAUTION: Combination drops will use the higher drop altitude.
CAUTION: A-22 containers with 26 foot ringslot parachutes must be dropped, during unilateral training, at over 1100 feet AGL. 850 feet plus or minus 150 feet is needed to decelerate the load to an acceptable velocity for payload survivable.

8.4. C-141/C-17/C-5 Aerial Delivery Ballistics General. The following charts contain ballistic data for a variety of load and parachute types in use by all four services. The data represents average information derived from aerial delivery test run by the US Army Airborne Board, US Army Natick Laboratory, and the US Air Force Mobility Center (USAFMOBCENT). Where exact data is not depicted, interpolate between given values. For heavy equipment, the exit times given represent an average value based on the load being rigged approximately two-thirds aft of the bulk head. Weight ranges depicted here do not supersede technical orders or rigging manuals. All weights represent total rigged weights.

SATB (Standard Airdrop Training Bundle)

Table 8.4. SATB Ballistic Data.

15 Pound - Standard Airdrop Training Bundle			
VD (feet)	0		
TFC (feet)	0		
RF (feet)	23.8		
Exit Location	**Door/Ramp**	**Bomb Rack**	
	Simulating Per	**Simulation HE**	**Simulating CDS**
FTT (sec)	2.2	1.9	2.2

Free Fall Ballistic Data

Table 8.5. Free Fall Ballistic Data.

Horizontal Distance of Fall (Yards/Meters)					
	Ground Speed (Knots)				
Abs Alt (ft)	**110**	**120**	**130**	**140**	**150**
1000	400/367	433/397	466/428	499/458	532/488
950	392/360	424/389	457/419	490/450	522/479
900	384/352	416/382	448/411	480/440	512/470
850	375/344	407/373	439/403	471/432	503/462
800	366/336	398/365	430/395	462/424	494/453
750	357/328	388/356	419/384	450/413	481/441
700	347/318	377/346	406/372	435/399	465/427
650	337/309	365/335	393/361	421/386	449/412
600	325/298	356/324	380/349	407/373	435/399
550	313/287	340/312	366/336	392/360	419/384
500	300/275	326/299	351/322	376/345	402/369
450	285/261	310/284	334/306	358/328	383/351
400	268/246	292/268	315/289	338/310	362/332
350	250/229	273/250	295/271	317/291	340/312
300	231/212	253/232	273/250	293/269	315/289
250	209/192	230/211	249/228	268/246	289/265
200	185/170	203/186	220/202	237/217	255/234
150	157/144	173/159	188/172	203/186	219/201
100	126/116	138/127	150/138	162/149	174/160
50	87/80	94/86	101/93	108/99	115/106

NOTE: To obtain Forward Travel Distance (FTD), multiply applicable Exit Time by ground speed (knots), divide by 1.78 (1.94 if using meters), and add to the horizontal distance of fall. For drop altitudes above 600 feet AGL, subtract 40 yards (37 meters) from FTD.

Personnel

Table 8.6. part 1, Personnel Ballistic Data.

	Static Line Personnel		
Type Chute	S-10/11/12/17/18/, T-10 A/B/C,MC1-1 A/B/C		
FTT (sec)	3.2 (Door) / 3.8 (Ramp)*		
VD (feet)	180		
TFC (sec)	5.4		
	HALO Personnel		
Free Fall RF (ft/sec)	156.6		156.6
ET (sec)	1.7 (Door) / 2.3 (Ramp)*		1.7 (Door) / 2.3 (Ramp)*
Type Chute	MC-3, MC1-3, MT1X/S, MC-4		MC-1, MC1-2
DT (sec)	3.4		3.3
DD (feet)	380		242
Rate of Fall (Static Line and HALO, deployed)			
			RF
S-10/11/12/17/18, T-10 A/B, MC1-1 A/B			I
T-10C, MC-1/3, MC1-2/3, MT1-X/S, MC-4,			II
MC1-1C/Low Porosity set 10			III
	Rate of Fall (feet/second)		
Load Weight (pounds)	**I**	**II**	**III**
150	14.5	14.3	13.0
175	15.5	15.2	13.8
200	16.4	16.0	14.6
225	17.4	16.8	15.4
250	18.3	17.6	16.3
275	19.2	18.4	17.1
300	20.0	19.2	18.0
325	20.9	20.0	18.8
350	21.7	20.7	19.7
375	22.4	21.5	20.5
400	23.1	22.3	21.4
425	23.8	23.0	22.2

***NOTE: When authorized by operational procedures directives.**

Personnel

Table 8.6. part 2, Personnel Ballistic Data.

HALO			
Drop Pressure Altitude	**VD (feet)**	**TFC (sec)**	**DQ (sec)**
1000	1380	9.4	2.4
2000	1395	9.4	2.5
3000	1415	9.5	2.5
4000	1440	9.6	2.5
5000	1485	9.7	2.5
6000	1495	9.8	2.5
7000	1525	9.9	2.6
8000	1565	10.0	2.6
9000	1605	10.1	2.6
10000	1645	10.2	2.7
11000	1685	10.4	2.7
12000	1735	10.5	2.7
13000	1785	10.6	2.8
14000	1835	10.7	2.8
15000	1890	10.9	2.8
16000	1950	11.0	2.9
17000	2005	11.2	2.9
18000	2065	11.3	2.9
19000	2130	11.5	3.0
20000	2190	11.7	3.0
21000	2255	11.9	3.1
22000	2320	12.1	3.1
23000	2395	12.3	3.2
24000	2455	12.5	3.2
25000	2520	12.8	3.3
26000	2590	13.0	3.3
27000	2670	13.3	3.4
28000	2750	13.6	3.4
29000	2840	14.0	3.5
30000	2940	14.3	3.5

CDS

Table 8.7. Part 1, CDS Ballistic Data.

Type	**68 Inch Pilot Chute Hi-Velocity**			**Type**	**Hi-Velocity 12’ RS**			
Aircraft	C-141 (130 KIAS)			**Aircraft**	C-141/C-17			
Load Wt (lbs)	75	150	250	**TFC (sec)**	26.0			
VD (feet)	**Range (feet)**			**FTT (sec)**	2.4			
# Chutes	**1**	**2**	**3**					
150	380	475	515	**Load Wt (lbs)**	200	300	400	500
300	400	550	650	**RF (ft/sec)**	54.0	65.0	76.0	87.0
600	400	600	750	**Pressure Alt**	**VD (ft)**	**Press Alt**		**VD (ft)**
900	400	600	790	1000	1700	15000		2120
1200	400	600	800	5000	1820	20000		2260
1500	400	600	820	10000	1970	25000		2400

Table 8.7. Part 2, CDS Ballistic Data.

Type Chute	G-12D			Type Chute	G-12E		
Aircraft	C-141			Aircraft	C-141/C-17		
VD (feet)	325			VD (feet)	320		
TFC (sec)	3.9			TFC (sec)	11.1		
DQ (sec)	3.0			DQ (sec)	1.0		
Load Wt (lbs)	RF (ft/sec)	Load Wt	RF (ft/sec)	Load Wt	RF (ft/sec)	Load Wt	RF (ft/sec)
600	16.2	1700	23.2	600	13.7	1700	23.0
700	17.0	1800	23.8	700	14.8	1800	23.7
800	17.7	1900	24.4	800	15.8	1900	24.3
900	18.2	2000	25.0	900	16.7	2000	25.0
1000	18.9	2100	25.7	1000	17.6	2100	25.6
1100	19.4	2200	26.3	1100	18.5	2200	26.2
1200	20.0	2300	27.0	1200	19.3	2300	26.8
1300	20.6	2400	27.6	1300	20.1	2400	27.3
1400	21.3	2500	28.3	1400	20.7	2500	27.9
1500	21.9	2600	28.9	1500	21.6	2600	28.5
1600	22.5	2700	29.5	1600	22.3	2700	29.0

#/Type Chute	2 x G-12D	#/Type Chute	2 x G-12E
Aircraft	C-141	Aircraft	C-141
VD (ft)	460	VD (ft)	430
TFC (sec)	11.1	TFC (sec)	14.4
DQ (sec)	2.6	DQ (sec)	1.2
Load Wt (lbs)	3-4000	Load Wt (lbs)	2-4000
RF (ft/sec)	26.2	RF (ft/sec)	24.4
Exit Time(sec)	See Below	Exit Time(sec)	See Below

C-141		C-141	
Fuselage Station	Exit Time (sec)	Fuselage Station	Exit Time (sec)
1400	5.6	1175	7.3
1375	5.9	1150	7.4
1350	6.1	1125	7.5
1325	6.3	1100	7.6
1300	6.7	1075	7.7
1275	6.7	1050	7.7
1250	6.9	1025	7.8
1225	7.0	1000	7.9
1200	7.2	975	7.9

CDS

Table 8.7. Part 3, CDS Ballistic Data.

Type	**G-12E HAARS**						**Type**	**G-13 (door bdl)**				
Aircraft	**C-141/C-17**						**Aircraft**	**C-141/C-17**				
Activ Alt	1600-1900						**VD (ft)**	125				
Load Wt				1000	1500	2200	**TFC (sec)**	3.0				
Decel Dist (ft)				785	1220	1420	**DQ (sec)**	1.6				
Decel Tm (sec)				12.8	15.9	19.7	**ET (sec)**	1.4				
Deply RF (f/s)				16.7	20.8	26.7	**Load Wt**	**RF (f/s) by # of Chutes**				
Hi-V RF (f/s)				173	203	245	**(lbs)**	**1**	**2**	**3**	**4**	**5**
Press Alt (ft)	**VD (feet)**						50	8.6	6.6	-	-	-
5000				2400	3600	4900	100	11.7	9.0	7.1	6.5	6.0
10000				2850	4100	5350	200	16.7	12.3	10.5	9.0	8.3
15000				3300	4550	5300	300	20.4	15.2	13.0	11.2	10.2
20000				3800	5000	5800	400	23.7	17.8	15.0	12.9	11.8
25000				4250	5500	6800	500	26.4	19.9	16.8	14.4	13.2
Press Alt (ft)	**TFC (sec)**						600	29.0	21.8	18.3	15.9	14.5
5000-25000				16.8	17.6	18.0	800	33.3	25.2	21.1	18.4	16.8
Press Alt (ft)	**DQ (sec)**						1000	37.3	28.2	23.5	20.5	18.7
5000-25000				5.2	6.7	9.8	1200	40.8	31.0	25.8	22.5	20.4
ET (sec)	**See Table 10.4. part 2**						1400	44.0	33.4	27.8	24.3	22.2
							1600	47.0	35.7	29.6	26.0	23.7
							2000	52.3	39.9	33.0	29.0	26.3
							2500	58.9	44.4	36.7	32.2	29.4
							3000	-	48.5	40.0	35.3	32.3
							3500	-	52.4	43.3	38.0	34.8
							4000	-	56.0	46.3	40.8	37.3
							4500	-	59.5	49.3	43.3	39.5
							5000	-	-	52.0	45.5	41.7

CDS

Table 8.7. Part 4, CDS Ballistic Data.

Type		**G-14 CDS**		**G-14 (Door bdl)**		**Type**	**G-14 HAARS**			
Aircraft		C-141/C-17		C-141/C-17		**Aircraft**	C-141/C-17			
VD (ft)		180		180		**Load Wt**	300		500	
TFC (sec)		5.3		5.3		**Hi-Vel RF**	185		210	
DQ (sec)		2.0		2.0		**Deploy RF**	18.8		19.2	
ET (sec)		See **Table 8.4.** part 2		1.5		**Activ Alt**	Deceleration Distance (feet)			
Load Wt	**RF (ft/sec) by # Chutes**									
	1	2	3	4	5	500			1.0	1.5
50	7.5	6.0	4.3	-	-	1000			6.0	6.5
100	10.8	8.2	6.8	6.0	5.3	1500			11.0	11.5
200	15.6	11.5	9.8	8.7	7.7	2000			16.2	16.7
300	19.3	14.3	11.9	10.6	9.4	2500			24.0	24.5
400	22.2	16.4	13.8	12.3	11.0	**Activ Alt**	**Deceleration Time (sec)**			
500	24.8	18.4	15.4	13.8	12.3	500			0	5.1
600	27.3	20.3	16.9	15.1	13.5	1000			9.6	9.2
800	31.5	23.6	19.7	17.4	15.7	1500			19.7	13.2
1000	35.2	26.4	21.9	19.5	17.5	2000			29.8	17.3
1200	38.8	29.0	24.0	21.3	19.2	2500			32.0	21.4
1400	41.8	31.3	25.9	23.2	20.9	**Pressure Alt**	**VD (feet)**			
1600	44.6	33.5	27.8	24.8	22.4	5000			1250	2325
2000	49.8	37.4	30.8	27.6	25.0	10000			2000	3100
2500	55.3	41.8	34.4	30.7	28.2	15000			2725	3825
3000	61.0	45.6	37.7	33.5	30.8	20000			3475	4575
3500	-	49.2	40.7	36.2	33.3	25000			4225	5325
4000	-	52.6	43.3	38.7	35.8	**Pressure Alt**	**TFC (sec)**			
4500	-	55.9	46.0	40.9	38.0	5-25K			10.2	13.9
5000	-	59.0	48.7	43.2	40.0	**Pressure Alt**	**DQ (sec)**			
						5-25K			5.6	7.7
						Exit Time	See **Table 8.7.**, part 2			

CDS

Table 8.7. Part 5, CDS Ballistic Data.

Type	**22 Foot High Velocity Ring Slot Parachute**																
Aircraft	**C-141/C-17**																
Load Wt	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
RF	48.7	52.5	56.5	60.0	63.1	66.2	69.2	72.1	74.9	77.5	80.2	82.6	85.0	87.4	89.6	91.8	93.9
Press Alt	**VD (ft)**																
1000	650	675	700	725	750	760	770	800	825	850	875	885	900	925	950	975	1000
5000	825	850	890	920	940	970	990	1025	1050	1075	1125	1150	1175	1200	1225	1260	1290
10000	1025	1070	1110	1150	1190	1225	1260	1300	1340	1380	1425	1460	1500	1535	1575	1620	1660
15000	1240	1275	1330	1380	1430	1475	1530	1575	1625	1675	1725	1775	1825	1875	1925	1980	2040
20000	1425	1500	1550	1625	1675	1740	1800	1850	1900	1975	2040	2100	2150	2225	2290	2350	2410
25000	1625	1700	1775	1850	1925	2000	2075	2125	2200	2275	2350	2425	2500	2575	2650	2725	2800
Press Alt	**TFC (sec)**																
1000	7.6	8.0	8.3	8.6	9.0	9.3	9.5	9.8	10.1	10.4	10.8	11.2	11.4	11.7	12.0	12.3	12.6
5000	9.7	10.2	10.6	11.2	11.6	12.2	12.6	13.2	13.6	14.2	14.6	15.2	15.6	16.2	16.6	17.2	17.6
10000	12.3	12.8	13.6	14.3	15.2	15.8	16.5	17.2	18.0	18.8	19.5	20.3	21.0	21.6	22.3	23.0	23.7
15000	14.8	15.6	16.5	17.5	18.6	19.5	20.8	21.3	22.2	23.3	24.2	25.2	26.2	27.0	28.0	29.0	30.0
20000	17.4	18.3	19.4	20.7	22.0	23.0	24.2	25.4	26.6	28.0	29.1	30.2	31.5	32.5	33.6	35.0	36.2
25000	20.0	21.2	22.3	24.0	25.5	26.8	28.2	29.5	31.0	32.0	33.9	35.2	36.8	38.0	39.5	40.7	42.3
Press Alt	**DQ (sec)**																
1000	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.1
5000	1.9	2.0	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.1
10000	2.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.1
15000	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.1
20000	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9	3.0	3.0	3.1
25000	2.5	2.5	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.9	2.9	3.0	3.0	3.0	3.1

NOTES:

For exit times, refer to Table 8.7., part 2.

Requires HQ AMC/DOT approval to use this procedure.

CDS

Table 8.7. Part 6, CDS Ballistic Data.																	
Type	**26 Foot High Velocity Ring Slot Parachute**																
Aircraft	**C-141/C-17**																
Ld Wt	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
RF	43.0	46.4	49.6	52.7	55.5	58.3	61.0	63.5	66.0	68.3	70.6	73.0	75.1	77.2	79.2	81.0	82.4
Pr Alt	**VD (ft)**																
1000	75	100	125	150	175	200	225	250	275	300	325	340	360	400	425	450	475
5000	250	300	325	375	400	450	475	525	550	575	625	675	700	725	775	800	850
10000	475	550	575	850	700	750	800	850	900	950	1000	1050	1100	1150	1200	1225	1275
15000	725	775	850	925	975	1050	1125	1175	1250	1300	1375	1450	1500	1575	1650	1725	1775
20000	950	1025	1100	1200	1275	1350	1450	1500	1600	1675	1750	1850	1925	2000	2075	2175	2250
25000	1175	1275	1350	1450	1575	1650	1750	1850	1950	2025	2125	2250	2325	2400	2525	2625	2725
Press Alt	**TFC (sec)**																
1000	3.9	4.0	4.2	4.3	4.5	4.7	4.8	5.0	5.1	5.3	5.5	5.6	5.7	5.8	6.0	6.2	6.5
5000	5.2	5.4	5.6	5.8	6.2	6.4	6.7	7.0	7.2	7.5	7.8	8.1	8.4	8.6	8.8	9.2	9.5
10000	6.7	7.1	7.5	7.8	8.2	8.7	9.2	9.6	9.9	10.3	10.8	11.2	11.6	11.9	12.4	12.8	13.4
15000	8.2	8.7	9.3	9.8	10.4	10.9	11.5	12.2	12.6	13.2	13.7	14.2	14.8	15.3	15.8	16.5	17.2
20000	9.7	10.4	11.2	11.8	12.5	13.2	13.8	14.6	15.2	16.0	16.7	17.4	18.0	18.7	19.4	20.2	20.9
25000	11.2	12.2	13.0	13.7	14.6	15.4	16.2	17.2	17.9	18.8	19.7	20.4	21.2	22.0	22.8	23.7	24.6
Press Alt	**DQ (sec)**																
1000	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3
5000	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3
10000	2.1	2.2	2.2	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4
15000	2.3	2.3	2.4	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.3	3.3	3.4
20000	2.5	2.6	2.6	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.5
25000	2.7	2.7	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5

NOTES:

For exit times, refer to **Table 8.7.**, part 2.

Requires HQ AMC/DOV approval to use this procedure.

Heavy Equipment

Table 8.8. Part 1, Heavy Equipment Ballistic Data.

Type Parachute	G-11A							
Aircraft / Airspeed	C-5/C-17/C-141 140-150 KIAS							
# Chutes	1	2	3	4	5	6	7	8
VD (ft)	700	785	885	885	885	900	1000	1100
TFC (sec)	11.5	13.0	14.6	15.3	15.8	16.2	16.7	17.0
DQ (sec) 140 KIAS	2.1	2.3	2.5	2.7	2.9	3.1	3.6	4.1
DQ (sec) 150 KIAS	2.2	2.4	2.6	2.8	3.0	3.2	3.8	4.2
Load Wt (lbs)	2-5K	4-9K	8-14K	13-18K	17-23K	22-27K	26-32K	31-36K
RF (ft/sec)	21.5	20.0	21.5	22.5	23.3	25.3	27.0	28.0
ET (sec) C-141	6.2	6.2	6.2	6.2	5.7	5.6	5.5	5.7
ET (sec) C-5	5.5	6.3	6.4	6.6	6.9	7.3	6.7	6.9

Type Parachute	G-11B							
Aircraft / Airspeed	C-5/C-17/C-141 150 KIAS							
# Chutes	1	2	3	4	5	6	7	8
VD (ft)	500	435	515	580	650	710	850	1000
TFC (sec)	8.9	8.8	9.9	11.7	11.8	12.0	12.7	13.3
DQ (sec)	1.6	1.4	2.1	2.3	2.7	3.1	3.3	3.5
Load Wt (lbs)	2-6K	5-11K	10-16K	15-21K	21-27K	26-32K	31-37K	36-42K
RF (ft/sec)	18.5	19.3	20.7	19.3	20.0	20.8	22.3	23.7
ET (sec) C-141	6.2	6.2	6.2	6.2	5.7	5.6	5.5	5.7
ET (sec) C-5	5.5	6.3	6.4	6.6	6.9	7.3	6.7	6.9

NOTE: *C-141 rigged weight limit is 38,500 lbs except for test loads and contingency/wartime.*

Type Parachute	G-11C							
Aircraft / Airspeed	C-5/C-17/C-141 150 KIAS							
# Chutes	1	2	3	4	5	6	7	8
VD (ft)					804	935	980	1005
TFC (sec)					12.0	12.7	12.9	13.0
DQ (sec)					2.8	2.9	2.9	3.0
Load Wt (lbs)					20-25K	25-30K	30-35K	35-42K
RF (ft/sec)					22.5	22.1	22.3	22.7
ET (sec) C-141					5.7	5.6	5.5	5.7
ET (sec) C-5					6.9	7.3	6.7	6.9

#/Type Parachute	1 or 2 / G-12D	Rate of Fall (ft/sec)		
VD (feet)	540	Load Wt (lbs)	# of Chutes	
TFC (sec)	14.4		1	2
DQ (sec)	1.5	2000	26.4	19.8
ET (sec)	4.6	2500	29.4	22.1
ET (sec)	6.1	3000	32.3	24.3
ET (sec)	6.6	3500	34.8	26.2
		4000	37.0	28.0

Table 8.8. Part 2, Heavy Equipment Ballistic Data.

#/Type Parachute	2 / G-12E				
Load Wt (lbs)	2000	2500	3000	3500	4000
RF (ft/sec)	17.5	19.6	21.5	23.2	24.8
Aircraft / Airspeed		C-141 / 150 KIAS		C-5 / 150 KIAS	C-17 / 145 KIAS
VD (ft)		266		266	266
TFC (sec)		6.7		6.7	6.7
DQ (sec)		1.0		1.0	1.0
ET (sec)		6.1		6.6	6.1

3 / G-12E	
Aircraft	C-5/C-17/C-141
VD (ft)	290
TFC (sec)	7.1
DQ (sec)	1.0
WT (lbs)	RF (sec)
2500	16.3
3000	17.9
3500	19.3
4000	20.6
4500	21.9
5000	23.1
5500	24.2
6000	25.3

Chapter 9

C-130 AERIAL DELIVERY DATA

9.1. C-130 Aerial Delivery Airspeeds. Aerial delivery airspeeds are a function of the force required to inflate the parachute and the airdrop altitude to minimize damage to the airdropped object**. *For AFSOC only***, when the mission requires use of airspeeds other than those ***recommended***, ensure airspeed falls within the parachute airspeed range listed in **Chapter 10**. All crewmembers will be briefed on the drop airspeed.

Table 9.1. C-130 Aerial Delivery Airspeeds (airspeeds are KIAS).

	C-130
Personnel Static Line	130
Personnel HALO/HAHO	130110 - 150
Equipment/Combination	130 - 140*
Heavy Equipment	140
CRRC, RAMZ, CDS/CRS (except G-12E), HVCDS, Wedge, Ahkio Sled	130/140*
CDS/CRS (G-12E)	140
Door Bundle	130
SATB	Same as type load simulated
Recovery Kit	130
HSLLADS	en route airspeed
PSYOPS Material as required for desired area coverage (Chp 7)	

*Used when gross weight is above 120,000 lbs. For combination drops, use the higher airspeed KIAS.

9.2. C-130 Aerial Delivery Altitudes. The altitudes listed in **Table 9.2.** are the minimum altitudes above the highest point on the drop zone. Commanders may agree to higher altitudes. For formation drops, no aircraft will drop at a lower altitude than a preceding aircraft in the formation. When load compatibility or operational considerations permit, stack elements beginning with the lowest drop altitude. No aircraft will drop lower than its computed drop altitude. For combination drops, the load requiring the highest drop altitude determines the aircraft drop altitude. Airdrops at or above 3,000 feet AGL will be conducted with high altitude parachutes, either high velocity ring slot or high altitude high/low opening (HAHO/HALO). Minimum altitudes shown are intended to provide guidance and do not restrict the Army and Air Force commanders in their planning of combat operations. Altitudes are based on the technical design characteristics of the parachutes and represent the minimum at which the parachutes may be expected to perform their intended function with acceptable reliability. Use of lower altitudes than shown may result in the parachute(s) failing to achieve their design performance and introduce safety hazards to jump personnel or result in unacceptable damage to loads.

Table 9.2. C-130 Aerial Delivery Altitudes.

PERSONNEL	
Basic Airborne Trainees	1250 feet
Tactical Training	800 feet (Note 1)
Combat Operations	Jointly determined by the Airborne and Airlift Commanders
HALO (minimum opening)	2500 feet
SATB-P	500 feet
SATB-C	See type chute being simulated
EQUIPMENT (See Note 2)	
G-11A (1 parachute)	900 feet
(2-7 chutes)	1100 feet
(8 chutes)	1300 feet
G-11B (1 parachute)	700 feet
(2-4 chutes)	750 feet
G-11C/X (1-2 chutes)	1050 feet
(3-4 chutes)	1100 feet
(5 chutes)	1150 feet
(6-7 chutes)	1200 feet
(8 chutes)	1300 feet
G-12D (2-3 parachutes)	650 feet
G-12E (2-3 parachutes)	550 feet
SATB-H	See type chute being simulated
CDS/CRS (See Note 2)	
G-12D/E (1-6 containers)	400 feet
G-12D (7 or more containers)	600 feet
G-12D (2 or more parachutes)	600 feet
G-12E (2 or more parachutes)	550 feet
CRRC (G-12D/E)	600 feet (boat only), otherwise determined by personnel drop altitude
G-13/14 (1-2 containers)	400 feet
(3 or more containers)	500 feet
High Velocity(HVCDS)/12’, 22’, 26’ Ring Slot	100’ plus vertical distance for the load being dropped (A-22 containers with 26’ ring slot chutes, during unilateral training, use 1100 feet AGL)
RECOVERY KIT (22’ Ring Slot)	
Land	250 feet (minimum)
Water	250 feet (minimum), 300 feet (maximum)
HSLLADS	250 feet (min.)
DOOR BUNDLE	
G-13/14	300 feet (min.)
T-10B	400 feet (min.)
T-7A	300 feet (min.)
FREE FALL	
Day	100 feet (minimum), 200 feet (maximum)
Night	- No lower than minimum TF altitude, or NVG contour altitude as applicable. - Without TF capability, the minimum is 300 feet.

NOTE 1: If the following criteria are not met, the minimum altitude is 1,000 feet AGL:
(1) Static lines are used.
(2) Parachutes are equipped with anti-inversion devices.
(3) When using T-10 parachutes, use established exit control procedures.
(4) When using MC1-1A/B/C parachutes, use alternating door exit procedures (ADEPT). ADEPT does not apply to combat operations or special tactics personnel.

NOTE 2: IMC airdrops will be flown no lower than 500 feet above the highest obstruction within three nautical miles either side of the DZ centerline from the IP or slowdown point (whichever occurs last) to the DZ. Not applicable to aircraft with a fully operational terrain following system

9.3. Aerial Delivery Wind Limitations. Aerial delivery wind limits and restrictions will be based on the information contained in **Table 9.3.** and **Table 9.4.** When surface winds are known, airdrop decisions will be based solely on surface wind limitations. When surface winds are unknown (e.g., blind drops to unmanned DZs), the jumpmaster and army airborne mission commander (if designated) will be advised when drop altitude winds exceed 30 knots for personnel drops. For blind equipment and bundle aerial deliveries to unmanned DZs, the aircraft commander will make the decision to drop. For operational rescue missions, the decision to deploy the jumpers is determined by the jumpmaster and aircraft commander.

Table 9.3. Surface Wind Limits for Equipment Airdrops.

TYPE EQUIPMENT DROP	SURFACE WIND LIMITS(KTS)
AF Equipment	17
AF CDS using G-12 parachutes	13
AF CDS using G-13/14 parachutes	20
HAARS, High Velocity CDS or HSLLADS	No Restriction
AF Training Bundles (SATB)	25
Non-AF Equipment	At discretion of supported unit commander

Table 9.4. Surface Wind Limits for Personnel Airdrops.

TYPE PERSONNEL DROP	SURFACE WIND LIMITS
Static Line (Land)	13
Static Line (Water)	17
MFF (Land)	18
MFF (Water)	20
Pararescue (Water)	22 (S/L) 25 (HGRP)
Pararescue (Tree)	17
Non-AF Personnel (Static Line)	At discretion of supported unit DZSO

9.4. Aerial Delivery Parachute Ballistics. The ballistics of different types of parachutes vary. Each parachute is designed for a specific purpose and has its own peculiar characteristics. The data represents average information derived from aerial delivery test run by the US Army Airborne board, US Army Natick Laboratory, and the US Air force Mobility Center (USAFMOBCENT). Where exact data is not depicted, interpolate between given values. In all cases: Load Weight = Suspended Weight + Parachute Weight. Aircrews will not make airdrops using parachutes for which this instruction does not list ballistics unless the user provides approved ballistic data or "K" factor. The ballistics or "K" factor must be approved by the above mentioned agencies or the MAJCOM. This does not apply to formal tests

Table 9.5. C-130 G-11A Heavy Equipment Ballistic Data.

C-130 G-11A HEAVY EQUIPMENT BALLISTIC DATA

CHUTES	1	2	3	4	5	6	7	8
VD	700	785	885	885	885	900	1000	1100
TFC	11.5	13.0	14.6	15.3	15.8	16.2	16.7	17.0
DQ	2.1	2.3	2.5	2.7	2.9	3.1	3.6	4.1
LOAD WT	**RATE OF FALL**							
2000	16.3							
2500	18.9							
3000	20.7							
3500	22.9							
4000	24.5	18.3						
4500	25.9	19.5						
5000		20.6						
5500		21.5						
6000		22.5						
6500		23.7						
7000		24.5						
7500		25.2						
8000		26.0	21.2					
8500		26.6	21.8					
9000			22.5					
9500			23.0					
10000			23.8					
12500			26.0	23.1				
15000			29.2	26.0	23.9			
17500				27.7	25.3			
20000					27.2	25.1		
22500					28.5	26.5	25.0	
25000						28.0	26.2	
27500						29.1	27.3	26.0
30000							28.5	27.0
35000								29.1
40000								31.1

NOTE:

See **Table 9.6.** Part 2 for exit times.

Table 9.6. Part 1, C-130 Exit Times for Heavy Equipment.

C-130 EXIT TIMES FOR HEAVY EQUIPMENT (0-3000 FEET AGL)

EXTRACTION CHUTE	LOAD WT	FUSELAGE STATION			
		300-419	420-539	540-649	650-737
15' RS	2000	4.4	4.2	4.1	3.8
	2500	4.5	4.3	4.2	3.9
	3000	4.6	4.4	4.2	4.0
	3500	4.7	4.5	4.3	4.1
	4000	4.8	4.6	4.4	4.2
	5000	5.0	4.7	4.5	4.2
	6000	5.1	4.9	4.6	4.2
	7000	5.2	5.0	4.6	4.3
	8000	5.4	5.1	4.7	4.4
	8500	5.5	5.1	4.7	4.4
22' RS	7000	4.7	4.5	4.4	4.1
	8000	4.8	4.6	4.4	4.2
	9000	4.9	4.7	4.5	4.2
	10000	5.0	4.8	4.5	4.2
	11000	5.0	4.8	4.6	4.3
	12000	5.1	4.9	4.6	4.3
	13000	5.2	4.9	4.6	4.3
	14000	5.2	5.0	4.7	4.4
	15000	5.3	5.0	4.7	4.4
	16000	5.3	5.1	4.7	4.4
	17000	5.4	5.1	4.8	4.5
	18000	5.4	5.2	4.8	4.5
28' RS	14000	4.3	4.2	4.0	3.7
	16000	4.4	4.2	4.0	3.8
	18000	4.5	4.3	4.1	3.8
	20000	4.5	4.3	4.1	3.9
	22000	4.6	4.4	4.2	3.9
	24000	4.7	4.4	4.2	3.9
	28000	4.8	4.4	4.2	4.0
	32000	4.9	4.5	4.3	4.0
2 x 28' RS	25000	4.5	4.3	4.0	3.8
	27000	4.5	4.3	4.1	3.8
	29000	4.6	4.4	4.1	3.8
	31000	4.6	4.4	4.1	3.9
	33000	4.7	4.4	4.2	3.9
	35000	4.7	4.5	4.2	3.9
	37000	4.8	4.5	4.2	4.0
	39000	4.8	4.5	4.3	4.0
	42000	4.9	4.6	4.3	4.0

C-130 EXIT TIMES USING A/A37A-11 TOWPLATE EXTRACTION SYSTEM FOR HE

EXTRACTION CHUTE	LOAD WT RANGE	EXIT TIME
15 FOOT RS*	2500-8000	1.7
22 FOOT RS	8000-17000	3.0
28 FOOT RS	14000-28000	2.9
2 x 28 FOOT RS	25000-35000	2.7

***NOTE:** Drogue chute also serves as main extraction parachute.

Table 9.6. Part 2, C-130 Exit Times for Heavy Equipment.

HEAVY EQUIPMENT EXIT TIMES

CHUTE	LOAD WT RANGE	EXIT TIME
G-11A	2-5K	4.5
	4-9K	4.6
	8-14K	4.6
	13-18K	4.4
	17-23K	4.4
	22-27K	4.2
	26-32K	4.4
	31-36K	4.4
G-11B	2-6K	4.5
	5-11K	4.6
	10-16K	4.6
	15-21K	4.4
	21-27K	4.4
	26-32K	4.2
	31-37K	4.4
	36-42K	4.4
G-11C	20-25K	4.4
	25-30K	4.2
	30-35K	4.4
	35-42K	4.4
1/2 G-12D	ALL	4.6
2 G12E	ALL	4.6
3 G-12E	ALL	1.6

Table 9.7. C-130 G-11B Heavy Equipment Ballistic Data.

HEAVY EQUIPMENT

CHUTES	1	2	3	4
VD	383	435	515	575
TFC	8.8	9.3	10.3	12.3
DQ	1.4	1.6	1.9	2.2
LOAD WT	RATE OF FALL			
2000	13.9			
2500	15.4			
3000	17.0			
3500	18.4			
4000	19.7			
4500	20.8			
5000	22.0	15.8		
5500		16.5		
6000		17.2		
6500		18.0		
7000		18.6		
7500		19.4		
8000		20.0		
8500		20.6		
9000		21.3		
9500		21.9		
10000		22.5	18.4	
12500			20.2	
15000			22.5	17.3
17500				18.7
20000				20.2

NOTE: See **Table 9.6.** Part 2 for exit times.

Table 9.8. C-130 G-11C Heavy Equipment Ballistic Data.

C-130 G-11C HEAVY EQUIPMENT BALLISTIC DATA

CHUTES	5	6	7	8
LOAD WT	20-25K	25-30K	30-35K	35-42K
VD	804	935	980	1005
TFC	12.0	12.7	12.9	13.0
DQ	2.8	2.9	2.9	3.0
RATE OF FALL	22.5	22.1	22.3	22.7

NOTE: See **Table 9.6.** Part 2 for exit times.

Table 9.9. C-130 G-12D Heavy Equipment Ballistic Data.

C-130 G-12D HEAVY EQUIPMENT BALLISTIC DATA

VD	540		
TFC	14.4		
DQ	1.5		
CHUTES	**1**	**2**	**3**
LOAD WT	**RATE OF FALL**		
2000	26.4	19.8	16.5
2500	29.4	22.1	18.4
3000	32.3	24.3	20.2
3500	34.8	26.2	21.9
4000	37.0	28.0	23.3

NOTE: See **Table 9.6.**, Part 2 for exit times.

Table 9.10. C-130 G-12E Heavy Equipment Ballistic Data.

C-130 G-12E HEAVY EQUIPMENT BALLISTIC DATA

CHUTES	**2**	**3**
VD	302	317
TFC	7.0	7.5
DQ	1.5	1.6
LOAD WT	**RATE OF FALL**	
2000	17.5	
2500	19.5	16.3
3000	21.5	17.9
3500	23.2	19.3
4000	24.8	20.6
4500		21.9
5000		23.1
5500		24.2
6000		25.3

NOTE: See **Table 9.6.**, Part 2 for exit times.

Table 9.11. C-130 G-12D CDS Ballistic Data.

G-12D CDS									
LOAD WT	VD	RF	TFC	DQ	LOAD WT	VD	RF	TFC	DQ
600	355	16.2	6.3	2.5	1700	373	23.2	5.3	2.8
700	357	17.0	6.2	2.5	1800	374	23.8	5.2	2.9
800	359	17.7	6.1	2.6	1900	376	24.4	5.2	2.9
900	360	18.3	6.0	2.6	2000	377	25.0	5.1	2.9
1000	362	18.9	6.0	2.6	2100	378	25.7	5.0	3.0
1100	364	19.4	5.9	2.7	2200	380	26.3	4.9	3.0
1200	365	20.0	5.8	2.7	2300	382	26.9	4.8	3.0
1300	367	20.6	5.7	2.7	2400	384	27.6	4.7	3.1
1400	368	21.2	5.6	2.8	2500	386	28.3	4.6	3.1
1500	370	21.9	5.5	2.8	2600	388	28.9	4.5	3.1
1600	372	22.6	5.4	2.8	2700	390	29.5	4.4	3.2
2 X G-12D CDS									
2800	500	23.5	13.0	2.2	3200	500	24.8	13.0	2.2
2900	500	23.8	13.0	2.2	3300	500	25.1	13.0	2.2
3000	500	24.0	13.0	2.2	3400	500	25.6	13.0	2.2
3100	500	24.3	13.0	2.2	3500	500	26.1	13.0	2.2

Table 9.12. C-130 G-12E CDS Ballistic Data.

CDS G-12E			
CHUTES	1		2
VD	370		440
TFC	11.3		14.5
DQ	1.1		1.3
RATE OF FALL 1 G-12E			
LOAD WT	RF	LOAD WT	RF
600	13.7	1700	23.0
700	14.8	1800	23.7
800	15.8	1900	24.3
900	16.7	2000	25.0
1000	17.6	2100	25.6
1100	18.5	2200	26.2
1200	19.3	2300	26.8
1300	20.1	2400	27.3
1400	20.7	2500	27.9
1500	21.6	2600	28.5
1600	22.3	2700	29.0

RATE OF FALL 2 x G-12E

LOAD WT	RF
2-4K	23.6

NOTE: See Table 9.19 for exit times.

Table 9.13. C-130 G-13 Ballistic Data.

C-130 G-13 BALLISTIC DATA

TYPE	G-13 CDS			G-13 DOOR BUNDLE	
VD	330			125	
TFC	6.6			3.0	
DQ	1.6			1.6	
EXIT TIME	See Table 9.19.			1.4	
	RATE OF FALL (by # of chutes)				
LOAD WEIGHT	1	2	3	4	5
50	8.6	6.6			
100	11.7	9.0	7.1	6.5	6.0
200	16.7	12.3	10.5	9.0	8.3
300	20.4	15.2	13.0	11.2	10.2
400	23.7	17.8	15.0	12.9	11.8
500	26.4	19.9	16.8	14.4	13.2
600	29.0	21.8	18.3	15.9	14.5
800	33.3	25.2	21.1	18.4	16.8
1000	37.3	28.2	23.5	20.5	18.7
1200	40.8	31.0	25.8	22.5	20.4
1400	44.0	33.4	27.8	24.3	22.2
1600	47.0	35.7	29.6	26.0	23.7
2000	52.3	39.9	33.0	29.0	26.3
2500	58.9	44.4	36.7	32.2	29.4
3000		48.5	40.0	35.3	32.3
3500		52.4	43.3	38.0	34.8
4000		56.0	46.3	40.8	37.3
4500		59.5	49.3	43.3	39.5
5000			52.0	45.5	41.7

Table 9.14. C-130 G-14 Ballistic Data.

C-130 G-14 BALLISTIC DATA

TYPE	G-14 CDS		G-14 DOOR BUNDLE		
VD	180		180		
TFC	5.3		5.3		
DQ	2.0		2.0		
EXIT TIME	See Table 9.19.		1.5		
	RATE OF FALL (by # of chutes)				
LOAD WEIGHT	1	2	3	4	5
50	7.5	6.0	4.3		
100	10.8	8.2	6.8	6.0	5.3
200	15.6	11.5	9.8	8.7	7.7
300	19.3	14.3	11.9	10.6	9.4
400	22.2	16.4	13.8	12.3	11.0
500	24.8	18.4	15.4	13.8	12.3
600	27.3	20.3	16.9	15.1	13.5
800	31.5	23.6	19.7	17.4	15.7
1000	35.2	26.4	21.9	19.5	17.5
1200	38.8	29.0	24.0	21.3	19.2
1400	41.8	31.3	25.9	23.2	20.9
1600	44.6	33.5	27.8	24.8	22.4
2000	49.8	37.4	30.8	27.6	25.0
2500	55.3	41.8	34.4	30.7	28.2
3000	61.0	45.6	37.7	33.5	30.8
3500		49.2	40.7	36.2	33.3
4000		52.6	43.3	38.7	35.8
4500		55.9	46.0	40.9	38.0
5000		59.0	48.7	43.2	40.0

Table 9.15. C-130 High Velocity CDS Ballistic Data.

CDS (HI-VELOCITY)

TYPE	**68 INCH PILOT CHUTE HI-VELOCITY**		
LOAD WT	75	150	250
DROP ALT (AGL)	**FORWARD TRAVEL DISTANCE (FT)**		
150	380	475	515
300	400	550	650
600	400	600	750
900	400	600	790
1200	400	600	800
1500	400	600	820

TYPE	**12 FOOT RING SLOT HI-VELOCITY**			
TFC	26.0			
FTT	2.4			
LOAD WT	200	300	400	500
RF	54.0	65.0	76.0	87.0

PRESS ALT	1000	5000	10000	15000	20000	25000
VD	1700	1820	1970	2120	2260	2400

NOTE: See Table 9.19 for exit times.

Table 9.16. Part 1, C-130 22' and 26' Ring Slot Ballistic Data.

CDS HI-VELOCITY 22' RING SLOT

Load Wt	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
RF	48.7	52.5	56.5	60.0	63.1	66.2	69.2	72.1	74.9	77.5	80.2	82.6	85.0	87.4	89.6	91.8	93.9
Press Alt	**VD**																
1000	890	900	910	920	930	938	946	953	962	971	980	990	1003	1013	1023	1032	1041
5000	945	955	965	975	985	995	1005	1012	1022	1030	1040	1052	1063	1074	1085	1095	1105
10000	1025	1038	1050	1060	1070	1080	1090	1100	1110	1120	1130	1142	1154	1165	1177	1188	1199
15000	1110	1120	1130	1142	1155	1165	1175	1187	1199	1210	1220	1230	1243	1255	1267	1278	1290
20000	1190	1201	1212	1225	1240	1251	1262	1273	1285	1297	1308	1320	1335	1346	1359	1370	1382
25000	1275	1285	1297	1312	1325	1338	1350	1361	1373	1385	1398	1410	1425	1438	1450	1462	1475
Press Alt	**TFC**																
1000	13.6	13.7	13.8	13.9	13.9	14.0	14.1	14.2	14.2	14.3	14.4	14.5	14.5	14.6	14.7	14.8	14.8
5000	13.8	13.8	13.9	14.0	14.1	14.1	14.2	14.3	14.4	14.4	14.5	14.6	14.6	14.7	14.8	14.9	15.0
10000	14.0	14.1	14.1	14.2	14.2	14.3	14.4	14.5	14.6	14.6	14.7	14.8	14.9	14.9	15.0	15.1	15.2
15000	14.2	14.3	14.3	14.4	14.5	14.6	14.6	14.7	14.8	14.9	14.9	15.0	15.1	15.1	15.2	15.3	15.4
20000	14.4	14.5	14.5	14.6	14.7	14.8	14.8	14.9	15.0	15.1	15.1	15.2	15.3	15.3	15.4	15.5	15.6
25000	14.6	14.7	14.7	14.8	14.9	15.0	15.0	15.1	15.2	15.3	15.3	15.4	15.5	15.5	15.6	15.7	15.8
Press Alt	**DQ**																
1000	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.5	3.5
5000	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.5	3.5
10000	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.6	3.6
15000	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.6	3.6
20000	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.6	3.6
25000	2.8	2.9	2.9	3.0	3.0	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.6	3.7	3.7

NOTE: See Table 9.19 for exit times.

CDS HI-VELOCITY 26' RING SLOT

Load Wt	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
RF	43.0	46.4	49.6	52.7	55.5	58.3	61.0	63.5	66.0	68.3	70.6	73.0	75.1	77.2	79.2	81.0	82.4
Press Alt									**VD**								
1000	428	456	482	510	533	559	583	611	638	665	694	722	748	775	800	828	854
5000	465	495	523	552	578	605	632	662	689	719	749	779	806	834	862	891	918
10000	513	543	573	604	634	663	693	723	753	786	817	849	879	909	939	970	1000
15000	560	592	626	658	690	720	753	785	818	852	885	920	950	982	1015	1049	1080
20000	607	640	677	710	745	778	814	848	882	919	953	990	1024	1058	1090	1128	1162
25000	650	690	727	763	800	835	873	910	947	984	1020	1060	1095	1130	1165	1205	1240

Table 9.16. Part 2, C-130 22’ and 26’ Ring Slot Ballistic Data.

Press Alt								TFC								
1000	7.0	7.0	7.0	7.1	7.1	7.2	7.2	7.3	7.3	7.4	7.4	7.5	7.5	7.6	7.6	7.7	7.7
5000	7.1	7.2	7.2	7.3	7.4	7.4	7.5	7.6	7.6	7.7	7.7	7.8	7.8	7.9	8.0	8.0	8.1
10000	7.4	7.4	7.5	7.6	7.7	7.7	7.8	7.9	8.0	8.0	8.1	8.2	8.3	8.3	8.4	8.5	8.6
15000	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1
20000	7.8	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.4	9.5	9.6
25000	8.1	8.2	8.4	8.5	8.6	8.7	8.9	9.0	9.1	9.2	9.4	9.5	9.6	9.7	9.9	10.0	10.1
Press Alt								**DQ**									
1000	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.3	3.4	3.5	3.5	3.6	3.7	3.8
5000	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.3	3.4	3.5	3.5	3.6	3.7	3.8
10000	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.3	3.4	3.5	3.5	3.6	3.7	3.8
15000	2.7	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.9	3.9
20000	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.7	3.8	3.9	4.0	4.1
25000	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.6	3.7	3.8	3.9	4.0	4.1	4.1	4.2	4.3

NOTE: See Table 9.19 for exit times.

Table 9.17. C-130 G-12E HAARS Ballistic Data.

C-130 G-12E HAARS BALLISTIC DATA

LOAD WT	1000	1500	2000	2200
HI VELOCITY RF	173	203	238	245
DEPLOYED RF	16.7	20.8	25.0	26.7

LOAD WT	1000		1500		2200		2200	
ACTIV. ALT	**DECEL DIST**	**DECEL TIME**	**DECEL DIST**	**DECEL TIME**	**DECEL DIST**	**DECEL TIME**	**DECEL DIST**	**DECEL TIME**
1600	790	7.0	1240	10.4	1440	14.2	1440	14.2
1650	790	9.0	1235	12.2	1440	16.0	1440	16.0
1700	785	11.0	1230	14.2	1435	18.0	1435	18.0
1750	780	12.8	1225	16.0	1430	19.6	1430	19.6
1800	780	14.7	1220	18.0	1430	21.5	1430	21.5
1850	780	16.2	1220	19.5	1425	23.4	1425	23.4

LOAD WT	1000			1500			2000			2200		
DROP ALT	**VD**	**TFC**	**DQ**	**VD**	**TFC**	**DQ**	**VD**	**TFC**	**DQ**	**VD**	**TFC**	**DQ**
5000	3000	17.9	4.5	4100	18.5	6.8	5200	19.1	7.7	5200	19.1	7.7
10000	3400	17.9	5.0	4500	18.5	7.3	5600	19.1	8.2	5600	19.1	8.2
15000	3800	17.9	5.5	4900	18.5	7.8	6025	19.1	8.6	6025	19.1	8.6
20000	4250	17.9	6.0	5300	18.5	8.3	6450	19.1	9.1	6450	19.1	9.1
25000	4650	17.9	6.5	5750	18.5	8.8	6850	19.1	9.6	6850	19.1	9.6

NOTE: See Table 9.19 for exit times.

Table 9.18. C-130 G-14 HAARS Ballistic Data..

C-130 G-14 HAARS BALLISTIC DATA

LOAD WT	300		500	
HI VELOCITY RF	185		210	
DEPLOYED RF	18.8		19.2	
TFC	12.0		16.7	
DQ	6.1		7.5	
ACTIVATION ALTITUDE	**DECEL DIST**	**DECEL TIME**	**DECEL DIST**	**DECEL TIME**
500	100	0	150	5.1
1000	600	9.6	650	9.2
1500	1100	19.7	1150	13.2
2000	1620	29.8	1670	17.3
2500	2400	32.0	2450	21.4
PRESSURE ALT.	**VD**		**VD**	
5000	1675		3000	
10000	2300		3650	
15000	2950		4300	
20000	3600		4950	
25000	4225		5600	

NOTE: See Table 9.19 for exit times.

Table 9.19. CDS/CRS and CDS Tow Plate Exit Times.

C-130 CDS/CRS AND CDS TOW PLATE EXIT TIMES

TYPE CHUTE	**G-12D/G-12E**	**G-13/G-14**	**A/A 37A-11 Tow Plate**	**22, 26' and 28' Ring Slot Chutes**
FS	**EXIT TIME**	**EXIT TIME**	**EXIT TIME**	**EXIT TIME**
730	4.1	3.7	2.8	4.1
705	4.3	3.8	3.0	4.3
680	4.5	4.0	3.1	4.5
655	4.7	4.1	3.2	4.7
620	4.9	4.3	3.4	4.9
595	5.1	4.4	3.5	5.1
570	5.2	4.5	3.7	5.2
545	5.4	4.6	3.8	5.4
520	5.5	4.8	3.8	5.5
495	5.6	4.9	3.9	5.6
470	5.7	5.0	4.0	5.7
445-430	5.8	5.2	4.1	5.8

NOTE: When using CRS procedures, subtract 1.7 seconds from extracted value.

NOTE: When dropping bike bundles from the ramp, recommend using 1.0 second as the exit time.

Table 9.20. C-130 Personnel Ballistic Data.

PERSONNEL BALLISTIC DATA

TYPE CHUTE	STATIC LINE PERSONNEL S-10/11/12/17/18, T-10A/B/C, MC1-1A/B/C	
VD	180	
TFC	5.4	
FTT	3.2 DOOR	3.8 RAMP

RATE OF FALL--Static Line and HALO (Deployed)	
TYPE CHUTE	**RATE OF FALL COLUMN**
S-10/11/12/17/18, T-10A/B, MC1-1A/B	**I**
T-10C, MC1/3, MC1-2/3, MT1X/S, MC-4 & 5	**II**
MC1-1C/LOPO Set 10	**III**

LOAD WT	**RF**			**LOAD WT**	**RF**		
	I	II	III		I	II	III
150	14.5	14.3	13.0	350	21.7	20.7	19.7
175	15.5	15.2	13.8	375	22.4	21.5	20.5
200	16.4	16.0	14.6	400	23.1	22.3	21.4
225	17.4	16.8	15.4	425	23.8	23.0	22.2
250	18.3	17.6	16.3	450	24.4	23.8	23.1
275	19.2	18.4	17.1	475	25.0	24.6	23.9
300	20.0	19.2	18.0	500	25.6	25.4	24.7
325	20.9	20.0	18.8				

NOTE: To compute the CARP data for RAMZ containers, divide the total container weight by two and apply the ballistic data for a single personnel T-10A/B parachute.

Table 9.21. C-130 Personnel HALO Ballistic Data.

Personnel HALO Ballistic Data

FREE FALL RF		156.6					
DT		3.4 MC-3, MC1-3, MT1-X/S, MC-4 & 5			3.3 MC-1, MC1-2		
DD		380 MC-3, MC1-3, MT1-X/S, MC-4 & 5			242 MC-1, MC1-2		
EXIT TIME		1.7 DOOR			2.3 RAMP		
PRESS ALT	**VD**	**TFC**	**DQ**	**PRESS ALT**	**VD**	**TFC**	**DQ**
1000	1380	9.4	2.4	16000	1950	11.0	2.9
2000	1395	9.4	2.5	17000	2005	11.2	2.9
3000	1415	9.5	2.5	18000	2065	11.3	2.9
4000	1440	9.6	2.5	19000	2130	11.5	3.0
5000	1465	9.7	2.5	20000	2190	11.7	3.0
6000	1495	9.8	2.5	21000	2255	11.9	3.1
7000	1525	9.9	2.6	22000	2320	12.1	3.1
8000	1565	10.0	2.6	23000	2395	12.3	3.2
9000	1605	10.1	2.6	24000	2455	12.5	3.2
10000	1645	10.2	2.7	25000	2520	12.8	3.3
11000	1685	10.4	2.7	26000	2590	13.0	3.3
12000	1735	10.5	2.7	27000	2670	13.3	3.4
13000	1785	10.6	2.8	28000	2750	13.6	3.4
14000	1835	10.7	2.8	29000	2840	14.0	3.5
15000	1890	10.9	2.8	30000	2940	14.3	3.5

Table 9.22. C-130 SATB and Door Bundle Ballistic Data.

STANDARD AIRDROP TRAINING BUNDLE (SATB)

TYPE	15 LB SATB	
CHUTE	68" PILOT CHUTE	
VD	0	
TFC	0	
RATE OF FALL	23.8	
EXIT LOCATION	DOOR/RAMP	BOMB RACK
FTT	2.2	1.9

DOOR BUNDLE

CHUTE	**T-7A**	**CHUTE**	**T-10B**
TFC	2.0	**TFC**	5.4
VD	60	**VD**	180
FTT	2.2	**FTT**	3.2
LOAD WT	**RATE OF FALL**	**LOAD WT**	**RATE OF FALL**
200	22.2	90-149	14.4
350	25.6	150-350	SEE TABLE 12.17
500	29.0	--	--

NOTE: For Door Bundles rigged with G-13/14 chutes, refer to Table 9.19.

Table 9.23. C-130 HSLLADS/CRS and Recovery Kit Ballistic Data.

HSLLADS/CRS and Recovery Kit Ballistic Data

TYPE	CHUTE	VD	TFC	DQ	Exit Time in sec. according to TOTAL load wt					
					250	500	1000	1500	2000	2500
HSLLADS	22'RS	177	4.3	1.6	1.0	1.6	2.0	2.3	2.4	2.5
HSLLADS	28'RS	185	5.3	1.5	SAME AS ABOVE					
CRS	22'RS	177	4.3	2.2	REFER TO TABLE 9.xx					
CRS	28'RS	185	5.3	2.1	REFER TO TABLE 9.xx					
RECOVERY KIT (1 OR 2 MAN)					**FTT/EXIT LOCATION = DOOR/RAMP**					
SLOW-SPEEDKIT	22'RS	177	4.3	--	2.9					
HIGHSPEED-KIT	22'RS	177	4.3	--	2.3					

RATE OF FALL

LOAD WT	22' RS	28' RS	LOAD WT	22'RS	28'RS
50	13.5	10.0	300	32.2	23.9
100	18.7	14.0	350	35.2	26.0
150	23.0	16.9	400	38.0	28.0
200	26.9	20.0	500	42.0	32.5
250	29.9	22.0	600	47.8	34.0

Table 9.24. C-130 BLU-82 Ballistic Data.

BLU-82/B

RF	338								
VD	5550								
F.S.	455-473	474-509	510-551	552-588	589-623	624-653	654-689	690-718	719-731
ET	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8

NOTE: Exit time is a function of the loaded position of the forward end of the platform in relation to the end of the ramp.

BLU-82 BALLISTIC Data

DROP PRESS ALT	DQ	TFC	DROP PRESS ALT	DQ	TFC
6000	11.2	14.8	16000	14.1	10.2
7000	11.6	14.2	17000	14.4	9.9
8000	11.9	13.6	18000	14.6	9.6
9000	12.3	13.1	19000	14.9	9.2
10000	12.6	12.6	20000	15.1	8.9
11000	12.9	12.2	21000	15.4	8.6
12000	13.1	11.8	22000	15.6	8.2
13000	13.4	11.4	23000	15.9	7.9
14000	13.6	11.0	24000	16.1	7.6
15000	13.9	10.6	25000	16.3	7.3

Table 9.25. BLU-82 Ballistic Wind Table.

BLU-82 BALLISTIC WIND TABLE

RELEASE ALTITUDE (AGL)	BALLISTIC WIND LEVELS				
	1	2	3	4	5
6000	6000	5500	4500	3500	1500
7000	7000	6500	5000	4000	1500
8000	8000	7000	6000	4000	1500
9000	9000	8000	6500	4500	2000
10000	10000	8500	7000	5000	2000
11000	10500	9500	7500	5500	2000
12000	11500	10000	8000	5500	2000
13000	12500	11000	8500	6000	2500
14000	13500	11500	8500	6000	2500
15000	14500	12500	9500	6500	2500
16000	15500	13000	10000	7000	2500
17000	16000	14000	10500	7000	2500
18000	17000	14500	11000	7500	3000
19000	18000	15000	11500	7500	3000
20000	19000	16000	12000	8000	3000
21000	20000	16500	12500	8000	3000
22000	20500	17500	13000	8500	3000
23000	21500	18000	13500	9000	3500
24000	22500	18500	13500	9000	3500
25000	23500	19500	14000	9500	3500

Table 9.26. Free Fall Ballistic Data.

Free Fall Ballistic Data

Horizontal Distance of Fall (Yards/Meters)					
	Ground Speed (Knots)				
Abs Alt (ft)	**110**	**120**	**130**	**140**	**150**
1000	400/367	433/397	466/428	499/458	532/488
950	392/360	424/389	457/419	490/450	522/479
900	384/352	416/382	448/411	480/440	512/470
850	375/344	407/373	439/403	471/432	503/462
800	366/336	398/365	430/395	462/424	494/453
750	357/328	388/356	419/384	450/413	481/441
700	347/318	377/346	406/372	435/399	465/427
650	337/309	365/335	393/361	421/386	449/412
600	325/298	356/324	380/349	407/373	435/399
550	313/287	340/312	366/336	392/360	419/384
500	300/275	326/299	351/322	376/345	402/369
450	285/261	310/284	334/306	358/328	383/351
400	268/246	292/268	315/289	338/310	362/332
350	250/229	273/250	295/271	317/291	340/312
300	231/212	253/232	273/250	293/269	315/289
250	209/192	230/211	249/228	268/246	289/265
200	185/170	203/186	220/202	237/217	255/234
150	157/144	173/159	188/172	203/186	219/201
100	126/116	138/127	150/138	162/149	174/160
50	87/80	94/86	101/93	108/99	115/106

NOTES:

1. To obtain Forward Travel Distance, multiply applicable exit time by groundspeed/1.78 (1.94 for meters) and add to horizontal distance of fall table.

2. For drop altitudes above 600 feet, subtract 40 yards from Forward Travel Distance.

3. Values obtained are valid approximations only for roughly cube-shaped loads having a weight range between 160 and 3840 pounds and with weight/volume ratios between 20 and 60 pounds/cubic foot.

Chapter 10

GENERAL GUIDANCE FOR USE OF USA AND USAF AIRDROP PARACHUTES

10.1. General. NOTE: The information found in this chapter is for information only, and is current data at the time of publication. Most current information and restrictions can be found in applicable Air Force series instructions or rigging manuals.

10.2. Personnel.

Table 10.1. Personnel (USA) Parachutes.

<table>
<tr><th colspan="5">Personnel (USA)</th></tr>
<tr><th>Type</th><th>Description</th><th>Minimum Alt (AGL)</th><th>Drop Airspeed (KIAS)</th><th>Remarks</th></tr>
<tr><td rowspan="2">T- I 0 A/B/C
MCI-I A/B/C</td><td>35’ Parabolic (T-10)</td><td>750</td><td rowspan="2">125 - 150</td><td>Jump altitude providing reserve parachute capability in event of main parachute malfunction.
All parachute canopies equipped with skirt anti-inversion net.</td></tr>
<tr><td>35’ 11 Gore TU Cut-out (MCI-1)</td><td>400</td><td>Combat jump altitude providing no reserve parachute capability.
Minimum altitude to evacuate aircraft in an airborne emergency using the main parachute.</td></tr>
<tr><td>MC-1</td><td>35’ Single Orifice</td><td>3000-5000</td><td>110 - 150</td><td>HALO free fall parachute with single orifice/slip riser parachute canopy and Type F-I B or Type FF- I Automatic Parachute Ripcord Release.
Minimum altitude based on a reserve parachute capability in the event of main parachute malfunction.
Minimum opening altitude setting for Type F- I B release is 5000 feet AGL.; for Type FF-I release, 3000 feet AGL.</td></tr>
<tr><td rowspan="2">MC-3</td><td rowspan="2">24’ Para Cmdr</td><td>2500</td><td rowspan="2">110 - 150</td><td>HALO free fall parachute with Para-Commander canopy and Type FF-2 automatic parachute ripcord release
Minimum altitude based on a reserve parachute capability in the event of main parachute malfunction.
Type FF-2 release imposes no minimum actuation altitude restriction.</td></tr>
<tr><td>1800</td><td>Minimum planned parachute actuation altitude providing no reserve parachute capability</td></tr>
</table>

Table 10.2. Personnel (USAF) Parachutes.

Personnel (USAF)

Type	Description	Remarks
S-10/S-11/S-12	35' Single Orifice	Used for special operations missions. Static lines used.
S-17/S-18/MCI-l	35' 11 Gore TU Cut-out	Refer to operational directives for altitude and airspeed restrictions.
MCI-2	35' 1 1 Gore TLJ Cut-out	HALO parachutes.
MCI-3	24' Para Cmdr	Refer to operational directives for altitude and airspeed restrictions.
Jumbo	28' Para Cmdr	

10.3. Equipment.

NOTE: Weight ranges shown are suspended weights based on figures found in FM 10-500-2 and TO 13C7-1-5, and are not meant for air release point computations. Total weight on rigged loads may fall outside these limits.

Table 10.3. Equipment Parachutes.

Equipment

Type	Description	Minimum Alt (AGL)	Drop Airspeed (KIAS)	Wt Range (Pounds)	Remarks
G-13	24'	400	125 - 150	200 - 500	Single parachute cargo container loads
		400		501 - 1000	Cluster of two parachutes
		500		1001 - 1500	Cluster of three parachutes
G-14	34'	300		200 - 500	Single parachute cargo container loads
		300	125 - 150	501- 1000	Cluster of two parachutes
		400		1001 - 1500	Cluster of three parachutes
12' High Velocity	12' Ring Slot	400	125 - 150	151 - 500	Intended for high altitude airdrops
22' High Velocity	22' Ring Slot	250	250	2200	
26' High Velocity	26' Ring Slot	500	125 - 150 250 For HSLLADS	501 - 2200	Intended for high altitude airdrops
G-12D G-12E	64	400 (G-12D) 300 (G-12E)	125 - 150	501 - 2200	Single parachute cargo container loads airdropped using the container delivery system
		450		2145 -3500	Applies to platform, extracted cargo/equipment using cluster of two or three parachutes

Table 10.4. Equipment Parachutes.

Equipment

Type	Description	Minimum Alt (AGL)	Drop Airspeed (KIAS)	#/ Wt Range(Pounds)	Remarks
G-11A	100’ Reefed 22’	900	125 - 150	I/ 2270 - 4250	Single parachute, platform, extracted loads
		1100		2/ 4251 - 8480 3/ 8481 - 12690 4/12691- 16880 5/16881- 21060 6/21061- 25270 7/25271- 29410	Platform, extracted cargo/equipment loads using clusters of two to seven parachute
		1300		8/29411- 33540	Platform, extracted cargo/equipment loads using cluster of eight parachutes
G-11B	100’	700	125 - 150	1/ 2270- 5000	Single parachute, platform, extracted loads
		750		2/5001-10000 3/10001-15000 4/15001- 20000	Platform, extracted cargo/equipment loads using clusters of two to four parachutes
		1100		5/20001- 25000 6/25001- 30000 7/30001- 35000	Platform, extracted cargo/equipment loads using clusters of five to seven parachutes
		1300		8/35001- 40000	Platform, extracted cargo/equipment loads using clusters of eight parachutes
G-11C	100’	975	125 - 150	1/ 3500 - 5000 2/ 5001 - 10000	Platform, extracted cargo/equipment loads using one or cluster of two parachutes
		1025		3/10001- 15000 4/15001- 20000	Platform, extracted cargo/equipment loads using clusters of three or four parachutes
		1075		5/20001- 25000	Platform, extracted cargo/equipment loads using cluster of five parachutes
		1125		6/25001- 30000 7/30001- 35000	Platform, extracted cargo/equipment loads using clusters of six or seven parachutes
		1225		8/33541- 42000	Platform, extracted cargo/equipment loads using cluster of eight parachutes

10.4. Forms Prescribed:

AF Form 4012, **Individual Air Drop Circular Error Record**

AF Form 4013, **Modified CARP Solution**

AF Form 4014, **Grid Overlay Plotter**

AF Form 4015, **High Altitude Release Point Computation**

AF Form 4017, **Modified HARP Solution**

AF Form 4011, **Low Altitude Leaflet Computation**

AF Form 4016, **High Altitude Leaflet Computation**

AF Form 4018, **Computed Air Release Point Computation**

AF Form 4018 **(Reverse)**

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFH 11-203, Weather for Aircrews

AFI 10-206, US Air Force Reporting Instructions

AFI 11-206, General Flight Rules

AFI 11-215, Flight Manuals Procedures

AFI 91-204, Investigating and Reporting US Air Force Mishaps

AFI 11-208, The US Military Notice to Airmen (NOTAM)

AFI 11-231, Computed Release Point Procedures

AFI 13-217, Assault Zone Procedures

AFPAM 11-216, Air Navigation

AFPD 13-2, Air Traffic Control, Airspace, Airfield, and Range Management

AFR 9-1, The Air Force Forms Management Program

FAA Handbook 7110.65, Air Traffic Control

FAA Handbook 7400.2, Procedures for Handling Airspace matters

FAR Part 91, General Operating and Flight Rules

T.O. 1C-5A-1-1, Performance Data

T.O. 1C-17A-1-1, Performance Data

T.O. 1C-141B-1-1, Performance Data

T.O. 1C-130E/H/J-1-1, Performance Data

Abbreviations and Acronyms

AFRC—Air Force Reserve Command

AGL—Above Ground Level

ANG—Air National Guard

ARC—Air Reserve Component (ANG and AFRC)

ATC—Air Traffic Control

AZAR—Assault Zone Availability Report

CCT—Combat Control Team, see Special Tactics Team (STT)

CRRC—Combat Rubber Raiding Craft

DZ—Drop Zone

ETA—Estimated Time of Arrival

ETD—Estimated Time of Departure

FAR—Federal Aviation Regulation

FL—Fight Level

ft—Feet

GPS—Global Positioning System

HUD—Head-Up Display

ICAO—International Civil Aviation Organization

IFR—Instrument Flight Rules

IMC—Instrument Meteorological Conditions

KCAS—Knots Calibrated Airspeed

KIAS—Knots Indicated Airspeed

MAJCOM—Major Command

MSL—Mean Sea Level

NAVAID—Navigational Aid

NM—Nautical Mile

NOTAM—Notice to Airmen

NVG—Night Vision Goggles

VFR—Visual Flight Rules

VMC—Visual Meteorological Conditions

WX—Weather

Terms

Airdrop.—The unloading of personnel or materiel from aircraft in flight.

AUTOCARP—. An airdrop in which the Computed Air Release Point (CARP) is automatically calculated in flight by aircraft avionics. Automatic or manual steering indications are provided to guide the aircraft to the release point.

Adverse Weather Aerial Delivery System (AWADS).—The precise delivery of personnel, equipment, and supplies during adverse weather, using a self-contained aircraft instrumentation system without artificial ground assistance, or the use of ground navigation aids.

Computed Air Release Point (CARP).—A computed air position where the first paratroop or cargo item is released to land on a specified impact point.

Containerized Delivery System (CDS).—CDS is designed to airdrop numerous individual containers, high velocity, low velocity, or HALO, and double containers at low velocity initiated primarily by gravity extraction.

Circular Error Average (CEA).—A computation used to track training data for each airdrop qualified crew member (primarily navigators). Compute CEAs by averaging all the drop scores (in yards) for each category specified in paragraph **1.7.**

Centerline Vertical Restraint (CVR).—An aircraft equipment add-on set of plates to the cargo compartment floor that provides vertical restraint of CDS bundles prior to delivery.

Combination Drop—. Combination drops are when jumpers exit from the aircraft immediately after the extraction of airdropped equipment.

Container Release system (CRS).—The CRS is a modification of HSLLADS components without the sling and is used for low speed gravity drops.

Cross Track Drift Offset.—The distance, perpendicular to drop zone centerline, the aircraft tracks to compensate for drift effect incurred during parachute descent.

Deceleration Distance (DD).—This factor is for high altitude-low opening (HALO) only. The vertical distance, in feet, that the load descends from chute actuation to full canopy deployment.

Deceleration Time (DT) For HALO only.—The vertical distance, in feet, that the load descends from chute actuation to full canopy deployment.

Deceleration Quotient (DQ).—A constant in seconds computed during airdrop tests that compensates for the nonlinear deceleration in forward speed of an airdropped load as it approaches stabilization. This factor is computed by subtracting exit distance from forward travel distance and dividing the difference by effective ground speed of the aircraft.

DQ = (FTD -ED) / EGS.

Drift Effect—. Horizontal distance traveled downwind by a load under full canopy.

Drop Zone (DZ).—A specified area upon which airborne troops, equipment, or supplies are airdropped.

Drop Zone Controller (DZC).—An individual on the DZ required to monitor all airdrop operations. Exception: Airdropping of unconventional warfare forces as defined by the Joint Strategic Capabilities Plan (JSCP) Annex E, does not require a DZC. AFI 13-217 defines DZC qualification duties and responsibilities.

Effective Ground Speed (EGS).—A factor used during testing to determine DQ. Computed by applying the mean true wind between drop and stabilization altitude to the aircraft true airspeed (TAS) and true heading

Exit Distance (ED).—The ground distance traveled by the aircraft during airdrop initiation. This distance measured along DZ axis from the initiation, green light signal, to the exit of the first object from the aircraft.

Exit Time (ET).—The elapsed time, in seconds, from the green light signal to the exit of the first object from the aircraft.

Flight Station—. An internal aircraft reference system, expressed in inches, referenced from an imaginary reference point in front of the aircraft. Fuselage station location for airdrop of equipment refers to the load’s center of gravity.

Forward Travel Distance (FTD).—The ground distance traveled by the airdropped load from the green light signal to stabilization. Plot FTD back from the point-of-impact (PI) along DZ axis.

Forward Travel Time (FTT).—Exit time plus deceleration quotient. A time constant that compensates for the horizontal distance the object travels from the green light signal until reaching stabilization. This factor is used to compute FTD.

Ground-to-Air Responder/Interrogator (GAR/I).—A beacon used to accomplish radar only airdrops (MC-130 only).

Ground Marked Release System (GMRS).—A network of panels or lights marking the release point. Reference AFI 13-217.

Ground Radar Aerial Delivery System (GRADS).—A method to position the aircraft for the airdrop (usually at high altitude) by using a ground based radar.

High Altitude Airdrop Resupply System (HAARS).—CDS modified for airdrop from high altitude with a sensor to deploy a cargo parachute when the right altitude is reached.

High Altitude High Opening (HAHO).—A high altitude airdrop in which parachutes deploy immediately upon exit from the aircraft.

High Altitude Low Opening (HALO).—A high altitude airdrop in which a period of freefall precedes actuation of the parachute(s). Does not include high altitude CDS using high velocity ring-slot parachutes (Hi-V).

High Altitude Release Point (HARP).—HALO/HAHO only. A point in space, computed by any means, over which the aircraft must be positioned at the time of release to ensure the load impacts the desired point on the ground.

High Speed Low Level Aerial Delivery System (HSLLADS).—A sling airdrop system employed to allow the aircraft to deliver loads from the aft cargo door and ramp at speeds up to 250 KIAS and at minimum altitudes (MC-130).

High Velocity Rate of Fall/Free Fall Rate of Fall.—This factor is the rate of fall in feet per second derived from parachute ballistic data, corrected for sea level standard day.

Initial Point (IP).—1. The first point at which a moving target is located on a plotting board. 2 A well-defined point, easily distinguishable visually and/or electronically, used as a starting point for the bomb run to the target. 3. Airborne—An air control point close to the landing area where serials (troop carrier air formations) make final alterations in course to pass over individual drop or landing zones. 4. Helicopter—An air control point in the vicinity of the landing zone from which individual flights of helicopters are directed to their prescribed landing sites. 5. Any designated place at which a column or element thereof is formed by the successive arrival of its various subdivisions, and comes under the control of the commander ordering the move. (Joint Publication 1-02).

Military Free Fall (MFF).—MFF is an employment concept encompassing both HALO and HAHO techniques of parachuting.

Mean Effective Wind (MEW).—An average wind direction and speed measured from the DZ surface to drop altitude as calculated by the DZC.

Parachute Deployment.—The stage in the airdrop process when a parachute has achieved its full opening potential.

Point of Impact (PI).—The specified location on the drop zone where the first object to exit the aircraft is expected to land.

Psychological Operations (PSYOPS).—Planned operations to convey selected information and indicators to foreign audiences to influence their emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals. The purpose of psychological operations is to induce or reinforce foreign attitudes and behavior favorable to the originator's objectives. Also call PSYOP.

Raised Angle Marker (RAM).—A "tented" panel device used in marking the intended point of impact of the drop zone that enhances drop zone acquisition.

Rate of Fall (RF).—RF is the vertical velocity, in feet per second, of the airdropped load while under full parachute canopy. RF is corrected to a standard day sea-level rate.

Safety Zone Distance.—Use safety zone distance only during peacetime personnel airdrops (excluding HALO/HAHO). A distance established by agreement between the airborne mission commander and the supported forces' commander subtracted from the DZ trailing edge to reduce the potential for off-DZ drops. For peacetime personnel airdrops, the safety zone will never be less than 200 yards. Do not compute safety zone distances for airdrops supporting unconventional warfare forces as defined by the Joint Strategic Capabilities Plan (JSCP) Annex E, or HALO/HAHO airdrops.

Sequential Drop.—Two or more extracted platforms released on a single pass over the DZ. Each platform, in turn, deploys the extraction parachute of the following platform.

Sight Angle—. The angle, in degrees below horizontal, along which the aircrew member, who initiates the airdrop release, sights a point on the ground. This ground reference is used in determining the initiation of the airdrop release sequence.

Stabilization.—Stabilization is the point in the drop sequence where descent is within 10 percent of a constant standard day sea-level rate of fall. Normally, forward velocity has decreased to zero.

Stabilization Altitude.—The altitude, in feet Above Ground Level (AGL), where stabilization occurs.

Stabilization Time.—Stabilization Time is the elapsed time from load exit to stabilization. Computation of Time of Fall Constant (TFC) also uses this factor.

Stick.—Number of parachutists or CDS loads exiting one side of the aircraft in one pass over the DZ.

Timing Point (TP).—Any visual or electronic reference used to measure the beginning of the release sequence. The timing point should be as close to the release point as possible for maximum accuracy.

Time of Fall Constant (TFC).—A constant in seconds computed during airdrop tests that compensates for the nonlinear rate of fall from load exit to stabilization. This factor is used to determine drift effect during stabilization.

TFC = ST - DQ

Towplate—.A primary aircraft component used to control the equipment airdrop sequence. This assembly allows for the transfer of force of the extraction chute from the towplate, connected to the aircraft, to the airdrop load. In the event of an extraction chute malfunction, the towplate assembly allows for the release of the chute without transferring the extraction force to the airdrop load.

Usable Drop Zone Length (UDZL).—Distance measured from the PI to the trailing edge (minus the safety zone distance for peace time personnel).

Usable Drop Zone Time (UDZT).—Usable drop zone length converted to time in seconds. Subtract one second for HARP computation. Minimum drop zone time is 3 seconds, regardless of DZ length.

Vertical Distance (VD).—The distance, in feet, a load falls after exiting the aircraft and prior to stabilization.

Verbally Initiated Release System (VIRS).—VIRS is a method of positioning aircraft for airdrop by verbal instruction from the DZC. Refer to AFI 13-217.

Visual and Verbal Signals:—

Green Light.—Verbal command and/or aircraft indicator light used to announce the arrival of the aircraft at the air release point. This action signals the start of the usable drop zone time.

Red Light.—Verbal command and/or aircraft indicator light used to announce the end of useable drop zone time.

Zone Marker.—An electronic reference used by aircraft avionics to navigate to an air release point.